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BRITISH ASSOCIATION OF GAS MANAGERS.

EIGHTEENTH ANNUAL MEETING.

PAPERS READ.

(I.)

ON THE TREATMENT OF GAS IN CONDENSATION, AS EFFECTED BY ST. JOHN'S APPARATUS.

By Mr. R. P. SPICE.

The invention to which I invite your attention is one having for its object that which we all aim at effecting in one way or another—namely, the increased economy of the retort-house, by so treating the gas as it leaves the retorts that the effect may be a greater yield, per ton of coal, of gas of a higher illuminating power, without promoting the formation of naphthaline.

The process, devised by Mr. St. John, of New York, is an extremely simple one, and consists of an arrangement of rectangular boxes, with external connections and internal dip-pipes, the superficial area of each set or series of the latter being equal to the area of the former; the "dip" or seal in each box being regulated by valves or taps, which control the current of tar and liquor as it flows continuously through the entire series of boxes.

The gas, tar, and liquor, as driven from the retorts, being conducted from the retort-house into the first box of the series, is made to pass through the whole; and afterwards the gas passes through vertical boxes to effect condensation, and thence, as may be desired, through scrubbers, for the purpose of arresting ammonia in the usual way.

This being the process, the question is—What is the effect? Having watched it in operation, and compared effects and causes, with as much regard to accuracy as the recorded facts at the Rochdale Corporation Gas-Works have enabled me, I have arrived at the following conclusions concerning the working of the two years 1878 and 1881; and my reasons for dealing with these two years are, that the year ending March 25, 1878, was the last in which the working was conducted without any aid from St. John's apparatus, and that ending March 25, 1881, was the first throughout which all the gas was passed through the apparatus, while in the two intervening years the process was only partially in use. The following are the facts:—

Gas made in	1881 =	265,736,000	feet.
	1878 =	245,043,000	,,
Increase in 1881 over	1878 =	20,693,000	,,
Make per ton of coal and cannel in	1881 =	10,211	,,
	1878 =	9,438	,,
Increased production per ton	1881 =	773	,,
Cannel carbonized in	1878 =	7,508	tons
	1881 =	3,630	,,
Less cannel in 1881 than in	1878 =	3,878	,,
Coal carbonized in	1878 =	18,453	,,
	1881 =	22,393	,,
Excess of coal used over	1878 =	3,940	,,
Coal and cannel carbonized in	1881 =	26,023	,,
	1878 =	25,961	,,
Increase of quantity carbonized in	1881 =	62	,,

Average cost per ton of cannel in the four years ending March 25, 1881		£0	19 10
Average cost per ton of coal for the same year		0	11 8½
Cannel carbonized in 1878 = 7508 tons, the average price being 19s. 10d. =		£7,445	8 8
Coal carbonized in 1878 = 18,453 tons, the average price being 11s. 8½d. =		10,802	7 4½
Total		£18,247	16 0½
Cannel carbonized in 1881 = 3630 tons, the average price being 19s. 10d. =		£3,590	15 0
Coal carbonized in 1881 = 22,393 tons, the average price being 11s. 8½d. =		13,108	14 0
Total cost of coal and cannel in 1881		£16,699	9 0
The cost of coal and cannel in 1878 being on the average of four years		£18,247	16 0
And the cost in 1881, at the same rates		16,699	9 0
The difference is the saving in cost effected by reducing the proportion of cannel required to maintain the same standard of illuminating power		£1,548	7 0

This comparative statement does not, however, give more than a small part of the total sum of the advantages realized in the year 1881 by means of the apparatus. To exhibit this in its entirety, I propose to refer to the financial account given in the statistics published by the Corporation, which are furnished as an appendix to this paper.

The profit of the year 1881 is stated at		£11,331	8 4
That of the year 1878 at		8,622	9 2
The apparent difference being an increase of		£2,708	19 2
But before the profit of 1881 was struck, the account was debited with an additional payment of £236 14s. 3d. for interest and an extra payment of £400 towards the sinking and depreciation funds, besides which £900 less was charged for public lighting, and 3d. per 1000 feet less was charged for gas supplied to private consumers in 1881 than in 1878; and, to put the two years on all-fours, these corrections must be made, viz:—			
Excess paid for interest	£236 14 3		
Excess debited to sinking and depreciation funds	400 0 0		
Less charged for public lighting	900 0 0		
Less charged private consumers	2,743 12 0		
		4,280	6 3
Increase on 1881 over 1878		£6,989	5 5
Subject to a reduction on account of the advantage due to the less amount paid per ton for coal and cannel in the latter year, amounting to not more than £1000		1,000	0 0
		£5,989	5 5

This increased economy, amounting in money value to 6d. per 1000 feet on the 219 million feet of gas sold in the year to private consumers, is attributable to the very gradual condensation effected by so passing it through the warm tar and liquor, on its way to the scrubbers and purifiers, that all the valuable light-giving compounds contained in the hydrocarbons separated from the coal in the retorts, are taken up by, and become chemically incorporated with the gas, instead of being thrown down, as they too commonly are by our older methods of condensation, finding their way, as they do, partly by gravitation, into the tar and liquor tanks, or settling, in the still more objectionable form of naphthaline, into various parts of the plant beyond the exhauster, occasioning serious inconvenience, expense, and loss.

This evil commonly extends beyond the gas-works into the distributory plant, occasioning thereby trouble and annoy-

ance to consumers, obliging them to complain and to send for the "gas man" to clear the service-pipes by using the familiar "service cleanser." It is, perhaps, not saying too much, to refer to this as being the curse of modern gas manufacture, and to describe the product as valuable matter wasted by being put into the wrong place.

If the use of this apparatus did no more than enable us to work at economically high heats without causing, as such heats unquestionably do, the inconvenience and loss due to the formation and deposit of naphthaline, it would be well worthy of our consideration; but as it has been proved beyond question that by its use a large percentage of cannel is dispensed with in the production of 18-candle gas, and the commercial result is to bring to the credit side of our balance-sheets, for the benefit of shareholders, ratepaying proprietors, and consumers alike, a large addition to profit, enabling us to reduce the selling price while maintaining or increasing illuminating power and purity, it behoves us to see to it that such benefits are largely secured for the common good.

[APPENDIX.]

STATISTICS OF THE ROCHDALE GAS-WORKS, AS PUBLISHED BY THE CORPORATION.

—	From March 25, 1877, to March 25, 1878.	From March 25, 1878, to March 25, 1879.	From March 25, 1879, to March 25, 1880.	From March 25, 1880, to March 25, 1881.
Receipts.				
Gas sold to private consumers	£38,266 19 7½	£38,237 2 8½	£38,865 0 9	£40,148 10 2
Gas supplied to public lamps	4,970 16 4	4,369 1 8	4,391 10 0	4,070 15 1
Tar and ammoniacal liquor	3,227 13 8½	3,017 11 2	3,082 17 1	3,320 5 4
Coke	2,643 8 4	2,507 14 8	2,184 16 5	2,719 13 10½
Sundries	168 6 11	80 0 0	24 14 3	51 14 5
	£49,277 4 11	£48,211 9 9½	£48,548 18 6	£50,310 18 10½
Expenditure.				
Cannel and coal used	£19,034 7 7	£17,360 10 8½	£15,980 1 4½	£16,382 13 1½
Lime used	160 19 11½	166 3 3	7,195 9 0	—
Salaries and wages	7,945 16 11½	7,640 19 11½	4,544 3 3	7,362 6 4
Expended on works, &c.	2,914 2 8½	3,688 18 6½	122 8 0	3,129 1 2
Printing and stationery	174 18 3	144 8 1	7,242 0 8	156 11 4
Interest of money	7,045 15 3	7,291 17 0	1,789 16 3	7,282 9 6
Rates and taxes	1,223 17 3	1,346 4 1	385 13 7	2,027 15 7
Rent of land	161 14 1	160 6 11	—	245 9 10
1-75th part of money borrowed paid to sinking and depreciation funds	1,993 3 8	2,393 3 8	2,393 3 8	2,393 3 8
	£40,654 15 8½	£40,192 12 2½	£39,662 17 9½	£38,979 10 6½
Profit this year	8,622 9 2½	8,018 17 7	8,886 0 8½	11,331 8 4
	£49,277 4 11	£48,211 9 9½	£48,548 18 6	£50,310 18 10½
Production.				
Number of feet of gas sold to private consumers	202,638,400	202,826,800	207,604,500	219,488,500
Do. estimated to have been burnt by street lamps	14,939,500	13,806,900	12,947,600	14,102,000
	217,577,900	216,633,700	220,552,100	233,590,500
Do. consumed on the works	2,258,600	2,304,200	2,263,900	1,557,500
Do. lost by leakage and condensation	25,206,500	25,810,100	26,983,000	30,588,000
	245,043,000	244,738,000	249,799,000	265,736,000
Loss per cent. by leakage and condensation	10·28	10·54	10·80	11·51
	Tons. cwts. qrs.	Tons. cwts. qrs.	Tons. cwts. qrs.	Tons. cwts. qrs.
Number of tons of cannel used	7,507 12 0	6,673 17 0	4,237 18 0	3,630 8 0
Do. coal used	18,453 8 0	18,125 5 0	20,602 2 0	22,392 13 1
	25,961 0 0	24,799 2 0	24,840 0 0	26,023 1 1
Gross average production of gas from each ton of cannel and coal used	9,438 cub. ft.	9,868 cub. ft.	10,056 cub. ft.	10,211 cub. ft.
Illuminating power, average	17·91 candles.	18·23 candles.	18·22 candles.	18·13 candles.
Average price of cannel per ton at works	£1 0 5·38	£0 19 11·01	£0 19 7·61	£0 19 4·79
Do. coal per ton at works	0 12 2·22	0 11 9·01	0 11 5·61	0 11 5·84
Cost of Gas.				
Net cost of gas per 1000 feet, reckoned on quantity sold, including 1-75th part of debt paid to sinking and depreciation funds	£0 3 1·44	£0 3 2·31	£0 3 1·40	£0 2 9·79
Net cost of gas per 1000 feet, reckoned on number of feet made, and excluding 1-75th part of debt paid to sinking and depreciation funds	0 2 7·95	0 2 7·57	0 2 6·72	0 2 3·54
Selling Price of Gas.				
Invoice price of gas per 1000 feet in the borough	£0 3 11	£0 3 11	£0 3 11	£0 3 8
Do. do. out of the borough	0 4 7	0 4 7	0 4 7	0 4 4
Amount charged per lamp per annum	2 18 6	2 10 0	2 10 0	2 6 0
Amount of discount allowed	2,295 9 2	2,184 10 2	2,385 13 1½	2,600 18 3
Number of services	19,312	19,815	20,162	20,391

Discussion.

Mr. J. WEST (Manchester) asked what was the best temperature for the gas to enter the apparatus, and again at what temperature it came out. The principal merit of the apparatus, it appeared to him, was to get rid of all the tar, so that no naphthaline should be formed.

Mr. W. CARR (Halifax) said it seemed to him that Mr. Spice claimed for this process three things—first, that it produced a large credit balance which could be used in reduction of price; secondly, that it increased the illuminating power of the gas; and, thirdly, that it prevented the deposit of naphthaline. These were three very important matters, and if the apparatus would do all that was claimed for it there could be no doubt about the advisability of adopting it. Still, he thought that Mr. Spice had hardly proved his case in the paper he had just read. The particulars given, although very good as far as they went, were hardly sufficient to demonstrate that the improvement in the results at Rochdale was owing to the application of this particular apparatus. It might be fairly admitted that it did increase the illuminating power, and though at first he was sceptical on this point, he had satisfied himself that it did really do so; but with regard to the other two matters he was by no means satisfied. He did not know whether the increase of illuminating power was not obtained more or less at the expense of the tar used in the apparatus. He knew that, at the time it was at work at Rochdale, a great improvement was going on in the management from year to year, and probably if they looked over the balance-sheets of 1877 and 1878—before the apparatus was put up—they would find that the same improvement had taken place between these two years. They also knew, as had been pointed out in the President's address, that considerable improvement had been going on over the same years in other works; so they might as well say that the improvement which had taken place in the balance-sheet at Leeds from year to year was due to the absence of the St. John apparatus, as to say that the improvement at Rochdale was altogether due to its presence. Much of the advantage gained at Rochdale was due to the fact that the management altogether had improved. He knew that the make of gas per mouthpiece had increased from something like 4000 to about 6000 cubic feet during these years, which, in itself, would put something to the credit side of the balance-sheet. As to the naphthaline, he did not know what to say about it. They were always more or less at a loss to know the laws which governed the formation and deposit of naphthaline. He knew works where the St. John apparatus was not used, where they were as free from naphthaline as they were in works where it was used; whereas there were others which were more or less troubled with it. His own experience had

been that the trouble did not increase with any increased temperature of distillation, for when he worked low heats he had more trouble with naphthaline than when he worked high. He did not say that the higher heats were the cause of the reduction, for he must confess that he was unable to account for it in any way; but he could not accept the statement that because they were not troubled with naphthaline at Rochdale it necessarily followed that it was because they used the St. John apparatus.

Mr. G. E. Stevenson (Peterborough) said from Mr. Carr's remarks he judged that during the last few years there had been an increase in the temperature of the retorts at Rochdale, and he understood Mr. Spice to say that with the St. John apparatus it was possible to work the retorts at a high heat, and at the same time produce gas of good illuminating power. Would Mr. Spice be so good as to say what was the reduction in the percentage of cannel used in the last year for which he gave the figures—viz., 1881—in comparison with the year 1878, before the apparatus was put up. He should also be glad to know what increase of illuminating power took place, or was there an increased make of gas with the same illuminating power as previously? The question was a very important one—whether the St. John apparatus enabled gas of high illuminating power to be produced, and at the same time a larger quantity to be obtained per ton of coal carbonized. The increase in the make per ton—viz., 773 feet—was greater than the 500 feet over which a discussion took place a few months ago. He did not understand very clearly the construction of the apparatus, or the principle on which it acted, and he should be pleased if Mr. Spice would say whether the heat of the tar was maintained artificially, or did the hot gas itself heat the tar and take from it the hydrocarbons with which the gas became charged?

Mr. T. O. Paterson (Birkenhead) said that his experience of the St. John apparatus at Rochdale was perhaps the first in this country, and he might say that although he did not find it carried out to the letter everything which the patentees claimed for it, yet the result was so far satisfactory as to induce the Corporation of that town to purchase the apparatus. It was said they were to have a very considerable increase in the yield of gas per ton of coal carbonized, which, however, did not, to his knowledge, result. The increase in illuminating power, however, was quite up to, and indeed better than was claimed by the patentees. When working without the apparatus during the winter months, they used about 33 per cent. of cannel, but during the time the apparatus was being used the percentage was reduced more than one-half, or down to 15 per cent., whilst at the same time the quality of gas was fully maintained. As to the utility of the apparatus as a condenser, he considered it acted more as a carburetter and a washer than as a condenser. The tarry matter was thoroughly washed out of the gas during its course through the apparatus, and the temperature of the tar at the inlet being maintained at 120° to 130° Fahr., it was quite possible to secure an increase of 1½ to 2 candles in illuminating power.

Mr. R. Morton (London Gas Company) said that it would be interesting to know what would be the result of using this apparatus where gas was made without cannel. At Rochdale cannel was used, and it was well known that tars from cannel and from common coals differed very materially; so that whilst gas might be able to take up illuminating power from cannel tar, he was afraid that the tar resulting from common coal, or with a very small percentage of cannel, would not have the same effect. It would be interesting to know, therefore, whether the apparatus had been applied where common gas only was made.

Mr. C. E. Botley (Wormwood Scrubbs, &c.) wished to ask Mr. Spice in what position he recommended the apparatus to be placed—immediately after the hydraulic main, or in conjunction with the horizontal main? With regard to temperature, Mr. Paterson said that from 120° to 130° Fahr. was the most favourable temperature for taking up hydrocarbons, and he would like to ask whether the same result would not be arrived at by carrying the gas in contact with the warm tar round the building. The plan he had adopted, on leaving the hydraulic main, was to take the heavy tar off in one direction to the tar-well, and conduct the gas round the buildings in contact with the lighter tar, so that it might take up the lighter hydrocarbons in its passage? Was it the particles of gas being brought into violent contact with the particles of tar in the same way as in the Pelouze and Audouin condenser that produced the advantages that were claimed for the St. John apparatus?

Mr. Henry Woodall (Leeds) asked if there were any difference in the mode of purification employed—whether oxide was used at one time and lime at another; or whether within the period referred to more efficient apparatus had been erected for taking out the carbonic acid in any way, because the taking out of this impurity would naturally have a great influence on the quality of the gas.

Mr. Denny Lane (Cork) thought it was a pity that a diagram of the apparatus was not exhibited, as it was a novelty. He thought that the arrangements for condensation in gas-works had not been carried out in as thorough and scientific a manner as some other departments of gas manufacture. He had rarely seen any automatic regulation of condensation in gas-works; but, if consideration were given to the number of changes that took place from the presence in combination of gas and tar, it was surely high time that there should be some definite method laid down for conducting the condensation. In former times, Mr. Lewis Thompson explained the presence of naphthaline in some cases and its absence in others in this way: He said that naphthaline was likely to occur in very cold or very hot weather, but not at other times; and the way in which he endeavoured to account for it was this. He said that certain hydrocarbons passed over when there was a moderate temperature, and that they were sufficient to keep the naphthaline in solution. At a very low temperature these hydrocarbons did not pass over, but were carried down in the condenser, and thus the naphthaline, not having the hydrocarbon to keep it in a state of solution, was deposited in the mains. On the other hand, when there was a very high temperature in the condenser, the result was that a larger proportion of naphthaline was carried forward than there was of solvent to suspend it. He (Mr. Lane) should be glad to know if these views were still entertained; for, if so, they pointed to what he had already remarked—that it was highly desirable they should ascertain the best conditions of condensation, and that these should be maintained under a system which would be practically automatic.

Mr. H. Cockey (Frome) regretted that he had only been able to hear the paper indistinctly; but he gathered the general facts stated, and the advantages said to be derived from the use of the apparatus. These he took to be an increased quantity of produce from the coal, higher illuminating power, and absence of naphthaline. He could not say anything about the produce, because he did not hear enough of the figures to gather what the results were, but as to the illuminating power, it struck him that there was nothing very particular in the figures quoted. He had himself, on a small scale—manufacturing something under 30 million feet per annum—in former years found that if the illuminating power were to be kept up, even to 14 or 15 candles, it was necessary to introduce a great deal of cannel; but for the last two or three years there had not been a particle of cannel used, and they had been able to keep the standard up to 17 candles. Then as to the naphthaline, by the introduction of higher heats and a more regular means of condensation, they had been able to do away with it entirely. He attributed this to the regular and gradual condensation. A short time since he saw the venerable Manager of the works at Brighton, Mr. Rutter, who, by introducing the same kind of gradual condensation, had been able to do away entirely, or except in an infinitesimal degree, with the naphthaline, which a few years ago troubled him excessively. It struck him, therefore, that they required some more proof than they had yet had that all the results attributable to the agency of the St. John apparatus were derivable from it.

Mr. C. Gandon (Crystal Palace District Gas Company) asked Mr. Spice if he did not consider that the action of the St. John apparatus was somewhat similar to that of Mr. Young's analyzer, because, as he understood, in both instances the gas and tar were kept together for some time in a hot state. The suggestion thrown out by Mr. Morton—whether the benefit derived was not chiefly to be expected in the case of gas of high illuminating power—was of some importance. With regard to naphthaline, there was no doubt that the higher the illuminating power of the gas the less likelihood was there of a deposit of naphthaline. With 14 to 16 candle gas there was no doubt an advantage by keeping it in contact with the tar, so long as the two were hot; but if they came in contact when cold, the very opposite would be the result, and there would be a decrease instead of an increase of illuminating power. Whether the increase due to the contact between the hot gas and tar was altogether permanent, was a matter of some doubt, on which he had not been able thoroughly to satisfy himself; but he certainly thought that keeping the gas and tar in contact in a hot state was a move in the right direction.

Mr. R. O. Paterson (Cheltenham) said that some of the figures Mr. Spice had given struck him as rather remarkable. He made out that the net advantage of the St. John apparatus was a money gain of £5900 per annum at Rochdale, and, working this out per 1000 feet of gas, it came to 6d. per 1000. This was followed by a statement that the advantage was obtained by preventing the hydrocarbons, which usually went to the tar-well, from going there, and retaining them in the gas. If this was the main advantage of the apparatus, and the large amount of 6d. per 1000 feet was gained, assuming that 10,000 feet of gas were made per ton of coal carbonized, it was equivalent to deriving the enormous advantage of 5s. per ton of coal from the use of the apparatus; in other words, taking 5s. per ton of coal out of the tar-well and putting it into the gas. He was not aware of any one deriving such a revenue as this from tar, even with rich hydrocarbons in it. On the general question he thought the statement made by his brother had considerable weight; for, in judging of the value of the apparatus, one year should not be compared with another simply, because the conditions might vary so enormously in the two years. The comparative trials to which his brother referred gave this as the net result—that comparatively little was gained in the amount of gas yielded per ton, but there was a decided improvement in the illuminating power of the gas up to an extent of 1½ candles, which appeared to be a fairly intelligible result. This he (Mr. Paterson) thought would be about the fair maximum value of the apparatus. It was also claimed for it that it prevented the deposit of naphthaline; but this he presumed could only mean that it did not promote the formation of it, and it must leave them, in the long run, very much as good managed works were at present in this respect. He would be glad to have Mr. Spice's explanation of the figures he had quoted from the paper.

Mr. A. C. Fraser (Bolton) said that a few years ago he had had some little experience in making gas without any cannel whatever, and with only ordinary coal produced gas of 20-candle power; but the tar produced at the low temperature—about 1700° Fahr.—was so valuable that it readily fetched 6d. a gallon, whereas ordinary tar was then only worth ¾d. to a 1d.

Mr. H. Townsend (Bradford) said that one of the chief advantages claimed for the St John apparatus was the prevention of the deposit of naphthaline; but, as Mr. Carr had said, there were works where naphthaline was unknown, even where the apparatus was not used. He happened to be connected with a works where this was, happily, the case, for since he had been at Bradford he had not had the pleasure of seeing his old friend "naphthaline" in any form. The Engineer, too, who had directed these works for a great many years told him that it was quite out of his experience; in fact, one of the pleasures he had looked forward to in connection with this meeting was to renew his acquaintance with his old friend. The cause of the absence of naphthaline was a very gradual reduction in the temperature; the tar was taken direct from the hydraulic main, and afterwards the gas passed through a breaker, which effected the mechanical deposition of most of the remaining portion of the tar. They always aimed at not reducing the gas to a lower temperature than 60° Fahr. at the outlet of the condenser.

Mr. C. Eastwood (Dewsbury) said he would like to know the selling price of the tar at Rochdale in 1878 and 1881.

Mr. J. Chew (Blackpool) said he had listened attentively to both the paper and the discussion, but unfortunately he could not hear distinctly all the figures in the paper. Certainly Mr. Spice had made some rather startling assertions, and, as far as he (Mr. Chew) understood, he claimed a gain of something like 6d. per 1000 feet by the use of the St. John apparatus. If this was so, it was an immense advance on what anybody had done before, and it occurred to him, on hearing this statement, to ask Mr. Spice where the increase of illuminating power came from. He was under the impression, rightly or wrongly, that the gain was to be derived from taking the gas at the right temperature, and passing it through the tar previously made from the same gas. If he were wrong, Mr. Spice would correct him; but if this were the case, he would find that not more than three-fourths of a candle, or one at the outside, could possibly be gained from the tar deposit, even in the tar well manipulated upon by some of the highest authorities; and if the gas was first to drop the tar and then take it up again, he could not see that there was such a great gain after all. As had been remarked, the value of the tar robbed of the light oils and naphthas was very much decreased, and the tar distiller would certainly not give the same price for it after all the light oils were taken from it as he did before. It was only a valuable commodity to him in proportion to the light oils in it. If a tar distiller found that he could get 20 gallons of light oil from tar distilled in any particular works, he would give a certain price for it; but if at another works gas was manufactured in such a manner that all the possible light oils were taken from it, it would be found that not more than 7, 8, or 9 gallons of light oil could possibly be obtained from a ton of tar, and he would not give as much for it. His (Mr. Chew's) own experience was that where low heats and plenty of cannel were used, a tar rich in light oil and naphtha was produced; but, on the other hand, where there were good sharp heats and common coal was used, there was not much, if anything, left in the tar that the gas was capable of carrying to the consumers' meters.

Mr. Corbet Woodall said, like many others, he laboured under the disadvantage of not hearing the paper very distinctly; but what he gathered, as much from the discussion as from the paper, brought him to the conclusion that there was something inherently wrong in the manner in which the particulars upon which the paper was based, had been laid before the Association. The inexorable logic of the balance-sheet did not apply to such a case as this, and he entirely agreed with the remarks just made by Mr. Chew, that in order to form an estimate of the value of such an apparatus as that dealt with in the paper, it was desirable that experiments should be made with it and without it, as nearly together as possible; both the materials used and the methods of investigation being the same in each case. As it was, so far as he could gather, they had in this case only the comparison of the balance-sheet and that of the illuminating power of the gas in different years. As almost every one who had spoken had suggested, there were so many circumstances which might influence both the one and the other, that it was impossible to arrive at anything like a conclusion as to the absolute value of the apparatus from any such figures. It had just been suggested to him that the value of 18-candle gas delivered into the holder in Yorkshire was from 7d. to 8d. per 1000 feet; and if this were so in a works where the St. John apparatus was not used, it would be interesting to know what was anticipated would be the value where it was in use, and whether or not they were speedily to have realized the condition which the Mayor had referred to that morning. Mr. Morton asked whether this apparatus had been used with common coal, which led him (Mr. Woodall) to speak of his own experience with it. Shortly after it was introduced, he had an opportunity of making a trial at the Phœnix Gas-Works, Vauxhall, and the result was that the gain in illuminating power was so slight that he was not disposed to recommend its use. He was bound, however, to say, that the method on which the experiment was conducted—owing to the manner in which the apparatus was fitted up—was unsatisfactory in itself; and, therefore, he would rather not name the exact results obtained in these trials. His main object in rising to speak was to suggest that this paper and discussion pointed out the wisdom of the resolution passed that morning—to encourage more direct and exact methods of investigation both into new processes proposed to be applied to manufacture, and into those difficult and doubtful questions which were raised as to the results obtained by one method or another.

Mr. F. W. Hartley begged to remind the members of a most interesting paper which was contributed some time ago by Mr. Leicester Greville to the Journal of Gas Lighting. Those disposed to consider this subject fully might, with the assistance of Mr. Greville's paper, be able to judge how far their tar was likely to be depreciated in value by the application of the St. John apparatus. Mr. Greville showed that the gas was enriched immensely by a very small addition of naphtha, which could be obtained sometimes from coal tar. The hydrocarbons contained in common coal gas, and which gave light, were not more than 4 per cent., and thus it could easily be understood that a very slight addition of light naphtha or benzole vapour would considerably increase the illuminating power.

Mr. T. Newbigging (Manchester) said they were much obliged to Mr. Spice for bringing this subject forward, although most present would agree that he had presented it perhaps in rather an exaggerated form; but he (Mr. Newbigging) was sure, from the discussion that had arisen, they would all derive much benefit from the paper that had been read. There was one point which he should not like to be overlooked with respect to comparing the illuminating power of gas at the present day with what it was some years ago. In most gas-works the proportion of cannel used had been materially reduced within the past five or six years, and this was due not only to improved methods of condensation and

purification, but very much (perhaps the greatest proportion) of the advantage must be ascribed to the improved gas-burners produced by Mr. Sugg and others. Within the last five or six years gas-burners had been improved to such an extent that the illuminating power of gas had been developed from 17 to 22 per cent., and this fact in itself largely accounted for the very material reduction which had taken place in the proportion of cannel necessary to be used in its production.

Mr. W. Sugg said it was important to bear in mind that the illuminating power of the gas in the towns from which the members came, who took part in the discussion, was not always mentioned, and this was an important omission. It was almost invariably the case that where the gas was of a quality between 17 and 18 candles, naphthaline was nearly unknown; but where from 14 to 16 candle gas had to be supplied, there was some difficulty in keeping naphthaline from depositing. There was no doubt, from the knowledge he had acquired, not so much from practical working—and therefore he spoke with some diffidence—as from information obtained from various works which he had visited, that where condensation was carried on very slowly, and the heat was brought down very regularly and gently, and never went down to a very low point, there was less trouble with naphthaline than where sudden changes or chills came on the condensing apparatus. Take the case of the old City of London Gas-Works, when under the direction of Mr. Mann. Even at a time when the illuminating power of the gas was not so high as it was now, he had no trouble with naphthaline, because he adopted the process of carrying the cooling main round the retort-house, and brought the gas slowly down to the ordinary temperature of the atmosphere, but never below it. With regard to the alteration of the standard of illuminating power owing to the use of improved burners, there was no doubt that some years ago, when the illuminating power of gas was first taken, there was no standard burner for the purpose of testing it, and people used different kinds. But, besides this, the apparatus used with the burners had been essentially improved, and a different mode of using the candles had been introduced. At the present time they were dealing with very careful methods, where a large number of errors had been eliminated. In the old times he had seen photometers put up close to walls where there was a great deal of reflection, but they had had now for a good many years a body called the Metropolitan Gas Referees, who had given very great attention to improving these matters, and who had entirely eliminated all possibility of reflection from the improved apparatus for testing now in use; and their action had not only influenced London, but every city in the Kingdom.

Mr. Spice, in reply, said he did not imagine that so many questions would have arisen with regard to the paper. His idea was that members would be surprised that he should have ventured to make such startling assertions; but he proposed to refer them all to Rochdale, and let them examine the facts for themselves, and if they did this it would confirm all he had said. He was not there as the exponent of a favourite system, nor with any ulterior object; he was there as one of themselves, to bring before them facts worth taking note of and examining into. He had been to Rochdale and inquired carefully into this matter, and he had not learnt that the great financial results he had mentioned had been, in any important measure, due to other improvements which had been introduced at the works whilst these experiments were going on. Guided solely by the facts he had ascertained, and by the statistical statements published by the Rochdale Corporation, extending over four years, he had given, in a condensed form, the actual results, and he defied any gentleman present to show that the conclusions he had arrived at were not based on the facts published by the Corporation. Some gentleman incidentally asked what might be expected if 6d. could be saved out of 8d. He had not come before them with any conjuror's trick of this kind, but with a statement of facts realized *at a particular works*. In round numbers, 7000 tons of cannel were formerly used, and 3500 tons now sufficed to produce the same results. The illuminating power of the gas was not lowered but raised. For 1878 it was 17·91 candles; in the year following it was 18·23, when the apparatus was partially used; in the next year, when it was also only partially used, it was 18·21; and in the year ending the 25th of March, 1881, it was 18·13, or 0·22 candle higher than in 1878. Besides this, with only 62 tons more coal used, 20,693,000 cubic feet more gas were made. This was due to working at higher heats, and keeping the coal a longer time under the operation of distillation So much more gas was obtained from the same quantity, practically, of raw material; the raw material being less rich in illuminating power than that which was used in 1878. It was not that this money would have gone into the tar-well—it would not have gone anywhere—it would not have been created. Some of the rich matter might, and some of it undoubtedly would have gone into the tar; and some, by these high heats, might have taken the form of naphthaline, which meant light-giving power kept from going to the gas-holder and the consumers' burners. As to the imagined decreased value of the tar, the tar and ammoniacal liquor in 1878 fetched £3278 13s. 8½d.; the next year, £3017 11s. 2d.; the next, £3082 17s. 1d.; and the next, £3320 5s. 4d.; so that they had not lost in diminished value of the tar any part of the great gain in gas-rental. With regard to the question as to where the apparatus was used where only common coal was employed, he must answer, "Nowhere;" but it was now in course of introduction, and he believed he might say in course of rapid introduction. The advantages in such cases could not be anything like the ones he had portrayed in those works where cannel was used to produce 18-candle gas; but every engineer would say that taking more gas out of a ton of coal, and improving that which he did take out, must result in benefit, wherever it was applied, and the precise benefit in each case must be a matter depending upon circumstances. It was not a new trick or a new idea; it was simply following out and more effectually doing that which Mr. Cockey intimated, and which had been suggested three or four years ago—breaking up the tar in its passage from the retorts to the condenser. With regard to condensation, Mr. Denny Lane had touched a point which was worth consideration, and was indeed an essential element—the *gradual* condensation of the gas. Some twelve months ago he introduced a jet of steam in an inner pipe in the condenser, and had the results of the experiment recorded; and he found that warming up the lower part of the condenser effected an improvement in the illuminating power of the gas to the extent of 0·75 candle; not that the ¾ of a candle was realized just where it was warmed, but after the whole process was completed, and the gas had been stored and sent out to the town. All these things were in the same direction in which Mr. St. John had gone; but Mr. St. John, he ventured to think, had gone farther than most or any of them. At all events he had done so much as to entitle his invention to serious consideration.

The President said that the discussion had been so full and exhaustive that it was not necessary for him to add anything to what had been said. He confessed that he had been a little startled at the figures which Mr. Spice had put forward. As had been very properly remarked, 6d. per 1000 feet was an extraordinary saving to effect by the process under consideration, as it would almost entirely wipe away the cost of gas manufacture. He was not one of those who thought that they could eat their cake and have it too, and he was not sanguine enough to think that if they made use of the light oils for enriching their gas they would not reduce the value of the tar. What they had to determine was whether the light oil was of more value to them for such a purpose, or as forming a constituent of the tar which they sold to the distiller. He would only add that at the Adderley Street works of the Birmingham Corporation a St. John apparatus had been in use for some months, and any member who wished might, by a visit to these works, obtain any information with regard to the apparatus which the officials there were themselves possessed of.

(II.)

ON GAS SUPPLY, BOTH FOR HEATING AND ILLUMINATING PURPOSES.

By C. W. Siemens, C.E., D.C.L., F.R.S.

When, within the memory of living men, the gas-burner took the place of the time-honoured oil-lamp, the improvement, both as regards the brilliancy of the light and the convenience of the user, was so great that the ultimate condition of perfection appeared to have been reached. Nothing apparently remained for the engineer to effect but improvements in the details of the works and apparatus, so that this great boon of modern times might be utilized to the largest extent. It is only in recent years that much attention has been bestowed upon the utilization of bye-products, with a view of cheapening the cost of the production of the gas, and that the consumer has become alive to the importance of having a gas of high illuminating power, free from nauseous constituents, such as bisulphide of carbon; thus providing a gentle stimulant for steady progress on the part of the gas-works manager.

This condition of steadiness and comfort has been somewhat rudely shaken by the introduction, within the last year or two, of the electric light, which, owing to its greater brilliancy and cheapness, threatens to do for gas what gas did for oil half a century before. The lighting of the City of London, and of many public halls and works, furnishes indisputable proof that the electric light is not an imaginary, but a real and formidable competitor with gas as an illuminant; and it is indeed time for gas engineers and managers to look seriously to their position with regard to this new rival—to decide whether to meet it as a foe, and contest its progress inch by inch, or to accept at once the new condition of things, conceding the ground that cannot reasonably be maintained, and to look about in search of such compensating fields as may be discovered, for a continuation or extension of their labours.

For my own part, I present myself before you both as a rival and a friend; as a rival, because I am one of the promoters of electric illumination; and as a friend, because I have advocated and extended the use of gas for heating purposes during the last twenty years, and am by no means disposed to relinquish my advocacy of gas both as an illuminating and as a heating agent. Speaking as a gas engineer, I should be rather disposed to regard the electric light as a welcome incentive to fresh exertion, confidently anticipating achievements by the use of gas which would probably have been long postponed under the continued *régime* of a monopoly. Already we observe, both in our thoroughfares and in our apartments, gas-burners producing a brighter and more powerful light than was to be seen previously; and although gas will have to yield to the electric light the illumination of our lighthouses, halls, and great thoroughfares, it will be in a position, I believe, to hold its own as a domestic illuminant, owing to its great convenience of usage, and to the facility with which it can be subdivided and regulated. The loss which it is likely to sustain in large appliances as an illuminant would be more than compensated by its use as a heating agent, to which the attention of both the producer and the consumer has latterly been largely directed.

Having, in the development of the regenerative gas furnace, had exceptional opportunities of recognizing the many advantages of gaseous over solid fuel, I ventured, as early as 1863, to propose to the Town Council of Birmingham the establishment of works for the distribution of heating gas throughout the town; and it has occurred to me to take this opportunity (when the Gas Managers of Great Britain hold their annual meeting at the very place of my early proposal) to lay before them the idea that then guided me, and to suggest a plan of operation for its realization, which at the present day will not, I venture to hope, be regarded by them as utopian.

The proposal of 1863 consisted in the establishment of separate mains for the distribution of heating gas to be produced in vertical retorts, that might be shortly described as Appold's coke ovens heated by means of "producer" gas and "regenerators." The heat of the retorts was to be increased beyond the ordinary limit, in order to produce a coke suitable for locomotive and other purposes; and the gas produced being possessed of less illuminating but of the same heating power, and being, with a view to cheapness, less thoroughly purified than ordinary retort gas, was to be distributed through the town as a heating agent, to be applied to the small boilers and furnaces of the numerous little factories peculiar to the district, as well as for domestic purposes. The Corporation applied for an Act of Parliament, but did not succeed in obtaining it, owing to the opposition of the existing Gas Companies, who pledged themselves to carry out such an undertaking if found feasible by them. I am ready to admit that at the time in question the success of the undertaking would have involved considerable practical difficulty; but I feel confident that the modified plan which it is my present object to bring before you would reduce these difficulties to a minimum, and open out, on the other hand, a new field of vast proportions, for the enterprise and energy of those interested in gas-works, and of great benefit to the public.

The gas-retort would be the same as at present, and the only change I would advocate in the benches is the use of the regenerative gas-furnace. This was first successfully introduced by me at the Paris Gas-Works in 1863, and has since found favour with the managers of gas-works abroad and in this country. The advantages that have been proved in favour of this mode of heating are—economy of fuel; greater durability of retorts, owing to the more perfect distribution of heat; the introduction of an additional retort in each bed, in the position previously occupied by the fire-grate; and, above all, a more rapid distillation of the coal, resulting in charges of four hours each, whereas six hours are necessary under the ordinary mode of firing. The additional suggestion I have now to make consists in providing over each bench of retorts two collecting-pipes, the one being set aside for illuminating, and the other for a separate service of heating gas. I shall be able to prove to you, from unimpeachable evidence, that the gas coming from a retort varies very greatly in its character during progressive periods of the charge; that during the first quarter of an hour after closing the retort the gas given off consists principally of marsh gas (CH_4) and other occluded gases and vapours, which are of little or no use for illuminating purposes; from the end of the first quarter of an hour, for a period of two hours, rich hydrocarbons such as acetylene (C_2H_2) and olefiant gas (C_2H_4) are given off; whereas the gases passing away after this consist for the most part again of marsh gas, possessing low illuminating power.

M. Ellissen, the late chief of the experimental department of the Paris Gas-Works, and actual President of the French Society of Gas Engineers, has favoured me with the result of a most interesting series of experiments, which he carried out in connection with the late M. Regnault, the eminent physicist, some years ago; the object of the experiments being to discover the proper period of time to be allowed for each charge. The accompanying diagram (see Appendix) gives the results of these experiments, showing in a striking manner that although the average illuminating power produced by the distillation of the coal did not exceed 1·35 Carcel burners, or 13·5 standard candles, according to our English mode of measurement, the gas given off from the end of the first quarter of an hour, during a period of two hours, possessed an illuminating power of 1·616 Carcel burners, or 16·16 standard candles.

According to the figures given in the valuable experiments of M. Ellissen, it appears that nearly two-thirds of the total production of gas takes place in the above period, whilst the remaining third is distilled during the first quarter of an hour and the last hour and three-quarters. It hence follows that by changing the direction of the flow of gas at the periods indicated, allowing the first results of distillation to flow into the heating-gas main, then for two consecutive hours into the illuminating-gas main, and for the remainder of the period again into the heating-gas main, one-third volume of heating and two-thirds of illuminating gas would be obtained, with this important difference, that the illuminating gas would be of 16·16 instead of 13·5 candle power, and that the heating gas, although possessed of an illuminating power of only 11·05 candles, would be preferable to the mixed gas for heating purposes, in being less liable in its combustion to deposit soot upon heat-absorbing surfaces, and in giving, weight for weight, a calorific power superior to olefiant gas.

These experiments not having been made for the particular objects I have in view, no account was taken of the quantity or quality of the gas coming from the retort during the first quarter of an hour. Judging by the nature of the curves given by M. Ellissen, it is reasonable to suppose that during the first quarter of an hour a considerable quantity of gas of very inferior illuminating power is given off, which, if taken into account, would further improve the result given in favour of separating the illuminating from the heating gases.

It will be observed that although the candle power of the illuminating gas would be raised to only 16·25, if two-thirds of the gas were set apart for this purpose—*i.e.*, after the first 25 minutes of distillation up to 2 h. 35 m. from the commencement of the charge—a gas equal to 18·04 candles could be obtained if the proportionate quantity of heating and illuminating gas were reversed, which might be effected by continuing the distillation for illuminating purposes from 25 m. to 1 h. 27 m. after the commencement of the charge; whilst if equal quantities of heating and illuminating gas were produced, which would result from allowing the illuminating gas to flow into its receiver from 25 m. to 2 h., the candle power of this portion of the gas would be raised to 16·78, as shown in the figures given below:—

Total gas produced from a ton of coal, 10,573·20 cubic feet, of 13·50 candle power.

	Illuminating Gas. Cub. Ft.	Candle Power.	Heating Gas. Cub. Ft.
Illuminating gas passing into its main 25 m. after commencement of charge:			
If two-thirds of quantity is used for illumination, from 25 m. to 2 h. 35 m. .	7048·8	16·25	3524·4
If half of quantity is used for illumination, from 25 m. to 2 h.	5286·6	16·78	5286·6
If one-third of quantity is used for illumination, from 25 m. to 1 h. 27 m. .	3524·4	18·04	7048·8

These important results are borne out by a series of photometric observations which were made some years ago by Mr. Sugg, which he has further supplemented verbally in stating

that the average illuminating power obtained by the distillation of Newcastle coal might be taken at 14-candle power, whilst two-thirds of the quantity, if separated in the manner I propose, would produce an average of 16 candles.

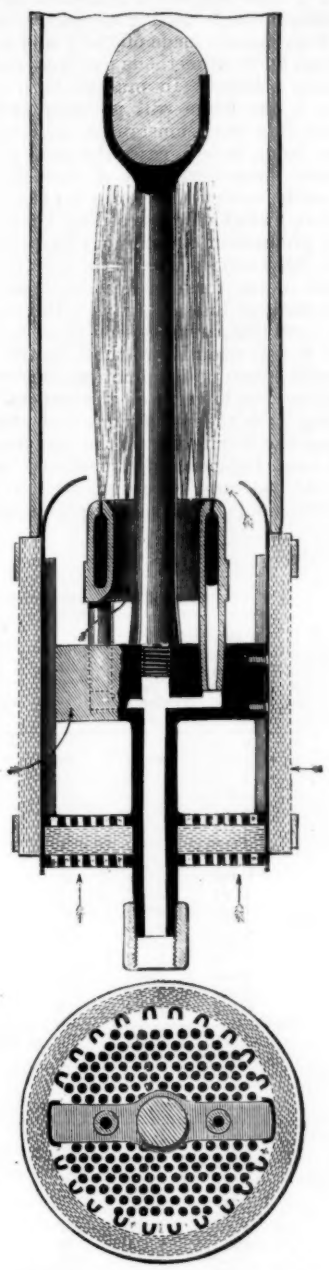
The working out of this plan would involve the mechanical operation of changing the direction of the gas coming from each bench of retorts at the proper periods of the charge. This could be accomplished by means of a simple reversing valve, similar to that applied for many years in reversing the current of the regenerative gas furnace, and a sand-glass may be placed in front of each bench of retorts, for the guidance of the man in charge as to the time when the reversal should be made. In order to distribute the two gases, a double set of gas-mains would certainly be required; but these exist already in the principal thoroughfares of many of our great towns, where, at one period or another, competing gas companies have been established, and it would not, I think, be difficult to utilize these services for the separate supply of illuminating and heating gas, the latter being taken into the houses and establishments only where it was asked for by the occupiers.

The public could well afford to pay an increased price for a gas of greatly increased illuminating power, and the increase of revenue thus produced would enable the gas companies to supply heating gas at a proportionately reduced rate. It would not be necessary to employ upon the heating gas the same expense and trouble in purification as is required for illuminating gas, because the products of combustion of the heating gas would not, as a rule, enter the apartments, but be conducted into the atmosphere through the ordinary chimneys. Heating the retorts by means of the regenerative gas furnace would, as already indicated, lead to an increased production of gas from each bench of retorts, and thus compensate for the reduced amount of illuminating gas in each operation. The heating gas might, without inconvenience, be sent through the pipes at a greater pressure than the illuminating gas, in order to make a given size of mains transmit an increased quantity.

The question may fairly be asked, whether a demand would be likely to arise for heating gas similar in amount to that for illuminating gas; and I may state that I am decidedly of opinion that although at the present moment the amount of gas supplied for illuminating purposes exceeds that for heating, the diminution in price of the latter would very soon indeed reverse these proportions. Already gas is used in rapidly increasing quantities for kitcheners, for the working of gas-engines, and for fire-grates. As regards the latter application, I may here mention that an arrangement for using gas and coke jointly in an open fire-place combined with an exceedingly simple contrivance with a view of effecting the combustion of the gas by heated air, has found favour with many of the leading grate-builders and with the public. Although this arrangement was suggested by me only last winter, several hundred of these grates are already in use in London, Manchester, Leeds, Glasgow, and other towns, showing how fully alive the public are at the present time to that great crying evil, "the smoke nuisance." It may be as well for me to mention here, that neither the regenerative gas coke fire-grate just alluded to, nor the plan I here advocate of separating the produce of gas-retorts, has been made by me subject-matter of letters patent; my time being already too much occupied in other directions to give that amount of constant attention to these subjects which the working of a patent necessitates.

As regards the use of illuminating gas, I have one more suggestion to make, which I feel confident will be viewed by you not without interest. The illuminating effect produced in a gas flame depends partly upon the amount of carbon developed in the solid condition in the body of the flame, and partly upon the temperature to which these particles are heated in the act of combustion. Having already shown how, by separation, a gas of greater luminosity may be supplied, it remains to be seen how the temperature of combustion may be raised. This may be effected to an extent that seems surprising, by certain mechanical arrangements, whereby a portion of the waste heat produced by the flame itself is rendered available to heat the gas and air sustaining the combustion of the flame, say to 600° Fahr., or even beyond this point.

The arrangement I have adopted for this purpose is represented on the sectional diagram, and I have also the pleasure of placing the burner itself before you, to enable you to test its efficiency by actual trial. The burner is of the ordinary Argand type, mounted in a small cylindrical chamber of sheet copper, connected with a vertical rod of copper, projecting upwards through the centre of the burner, and terminating



Siemens's Regenerative Argand Gas Burner.

in a cup-like extension at a point about 4 inches above the gas orifices, or on a level with the top of the flame. A small mass of fire-clay fills the cup, projecting upwards from it in a rounded and pointed form. The copper vessel surrounding the burner is contracted at its upper extremity, with a view of directing a current of air against the gas-jets on the burner, and on its circumference it is perforated for the admission of atmospheric air. The bottom surface is formed of a perforated disc covered with wire gauze, and wire gauze also surrounds the circumference of the perforated cylinder. The external air is heated in passing through these "regenerative" surfaces, and the flame is thus fed with air, heated to the point above indicated, which by more elaborate arrangements might be raised to a still higher degree. The ball of fire-clay, in the centre of the burner, which is heated to redness, serves the useful purpose of completing the combustion of the gas, and thus diminishes the liability to blackening of the ceiling.

The arrangement for transferring the heat from the tip of the flame to the air supporting its combustion is applicable also to an open batswing burner; but I have not yet had time to ascertain accurately the amount of increase of luminosity that may be realized with this class of burner.

I may here mention that another solution of the problem of heating the incoming air by the waste heat of the products of combustion has lately been brought under public notice by my brother, Frederick Siemens, which differs essentially

from the plan I have suggested, inasmuch as he draws the flame downwards through heating apparatus, and thence into a chimney. Experiments made officially and with great care have proved that by these methods the luminous effect of gas can be practically doubled. In practice both these methods of intensifying a gas flame will probably find independent application according to circumstances, the cause of increased luminous effect being in both cases the same.

From a purely theoretical point of view it can be shown that of the caloric energy developed in the combustion of gas, a proportion, probably not exceeding 1 per cent., is really utilized in the production of luminous rays; and that even in the electric light nine-tenths of the energy set up in the arc is dispersed in the form of heat, and one-tenth only is utilized in the form of luminous rays. It would lead us too far here to go into the particulars of these calculations, but it is important to call attention to them, in order to show the large margin still before us for practical improvements.

By the combined employment of the process for separating the illuminating from the heating gas with the arrangement for intensifying the luminosity of the gas flame previously described, the total luminous effect produced by a given consumption of coal gas may, according to the figures given, be increased threefold; thus showing that the deleterious effects now appertaining to gas illumination are not inseparably connected with its use.

My principal object in preparing this communication has been to call your attention generally to the important question of an improved gas illumination, and more particularly to the subject of a separate supply for heating gas, which, if carried into effect, would lead, I am convinced, to beneficial results, the importance of which, both to gas companies and to the public, it would be difficult to over-estimate.

[Appendix.]

"*Paris, June* 4, 1881.

"Dear Sir,—I send you herewith the result of my experiments, together with tables and curves. The very ingenious proposal that you have made would permit such a division of the total production of gas, that two-thirds could be employed for lighting and one-third for heating purposes, resulting in splendid illumination and much more rational heating.

"I am, dear Sir, &c.,

(Signed) "A. Ellissen.

"Dr. C. William Siemens."

Distillation in 4 hours.

Time of Observation.	Charge of 100 kilos. per Retort.				Charge of 110 kilos. per Retort.				Charge of 120 kilos. per Retort.			
	Gas Produced		Illuminating Power.	Numbers proportional to the Products of Columns 1 and 3.	Gas Produced		Illuminating Power.	Numbers proportional to the Products of Columns 1 and 3.	Gas Produced		Illuminating Power.	Numbers proportional to the Products of Columns 1 and 3.
	Per 100 kilos. of Coal. (1)	Per Cent. of Total Production. (2)	(3)		Per 100 kilos. of Coal. (1)	Per Cent. of Total Production. (2)	(3)		Per 100 kilos. of Coal. (1)	Per Cent. of Total Production. (2)	(3)	
	Cub. Mèt.			Litres.	Cub. Mèt.			Litres.	Cub. Mèt.			Litres.
0 h. 15 m.	2·571	8·412	98	1·764	1·430	4·868	140	1·540	2·024	6·773	105	1·785
„ 30	2·714	8·878	74	1·406	1·949	6·636	72	1·080	3·214	10·758	70	1·890
„ 45	2·999	9·813	78	1·638	2·599	8·849	74	1·480	2·499	8·366	75	1·575
1 h. 00 m.	2·857	9·346	84	1·680	2·469	8·407	79	1·501	2·619	8·765	84	1·848
„ 15	2·714	8·878	91	1·729	2·209	7·522	84	1·428	2·381	7·968	86	1·720
„ 30	2·999	9·813	94	1·974	2·339	7·965	90	1·620	2·262	7·570	91	1·729
„ 45	2·571	8·412	95	1·710	2·339	7·965	98	1·764	2·262	7·570	97	1·843
2 h. 00 m.	2·143	7·009	97	1·455	2·079	7·079	103	1·648	2·262	7·570	102	1·938
„ 15	1·714	5·607	105	1·260	2·079	7·079	105	1·680	2·262	7·570	108	2·052
„ 30	1·429	4·673	109	1·090	2·209	7·522	109	1·853	1·786	5·976	119	1·785
„ 45	1·429	4·673	121	1·210	1·690	5·752	115	1·380	1·786	5·976	125	1·875
3 h. 00 m.	1·286	4·206	129	1·161	1·560	5·310	127	1·524	1·309	4·382	128	1·408
„ 15	1·143	3·738	147	1·176	1·560	5·310	140	1·820	1·191	3·984	140	1·400
„ 30	0·858	2·804	160	960	1·299	4·425	153	1·530	0·953	3·187	149	1·192
„ 45	0·715	2·336	166	830	1·040	3·540	169	1·352	0·714	2·390	159	954
4 h. 00 m.	0·429	1·402	178	534	0·520	1·771	175	700	0·357	1·195	164	492
	30·571	100·000	Mean 100·8		29·370	100·000	Mean 103·3		29·881	100·000	Mean 101·4	

Distillation in 4 hours 48 minutes.

0 h. 15 m.	2·571	8·412	166	2·982	2·467	8·190	174	2·326	2·024	6·719	166	2·822
„ 30	3·000	9·812	102	2·142	3·117	10·344	101	2·424	2·738	9·090	100	2·300
„ 45	2·857	9·346	93	1·860	2·857	9·483	94	2·068	2·857	9·486	90	2·160
1 h. 00 m.	2·571	8·412	96	1·728	2·857	9·483	94	2·068	2·857	9·486	88	2·112
„ 15	2·286	7·477	98	1·568	2·727	9·052	97	2·037	2·619	8·695	89	1·958
„ 30	2·286	7·477	107	1·712	2·467	8·190	102	1·938	2·381	7·906	95	1·900
„ 45	2·143	7·009	112	1·680	2·337	7·759	107	1·926	2·143	7·115	98	1·764
2 h. 00 m.	2·000	6·542	118	1·652	2·207	7·328	109	1·853	1·905	6·324	110	1·760
„ 15	1·857	6·074	122	1·586	1·819	6·034	111	1·554	1·786	5·929	118	1·770
„ 30	1·715	5·607	127	1·524	1·559	5·171	117	1·404	1·667	5·533	126	1·764
„ 45	1·571	5·140	132	1·452	1·299	4·310	126	1·260	1·428	4·743	128	1·536
3 h. 00 m.	1·428	4·673	141	1·410	1·169	3·879	129	1·171	1·309	4·347	134	1·474
„ 15	1·286	4·206	147	1·323	0·909	3·017	136	952	1·072	3·557	136	1·224
„ 30	1·143	3·738	153	1·224	0·778	2·586	143	858	0·833	2·767	144	908
„ 45	0·857	2·804	166	996	0·650	2·155	151	755	0·715	2·372	152	912
4 h. 00 m.	0·571	1·869	171	684	0·520	1·724	169	676	0·595	1·976	157	785
„ 15	0·286	0·935	174	348	0·260	0·862	174	348	0·476	1·582	165	660
„ 30	0·143	0·467	176	176	0·130	0·432	183	183	0·476	1·582	169	676
„ 48	—	—	—	—	—	—	—	—	0·238	0·791	179	358
	30·571	100·000	Mean 121·0		30·129	100·000	Mean 111·2		30·119	100·000	Mean 114·0	

"*Experiments on the Variation of Production of Gas, and of its Illuminating Power, at Different Periods of the Distillation.*

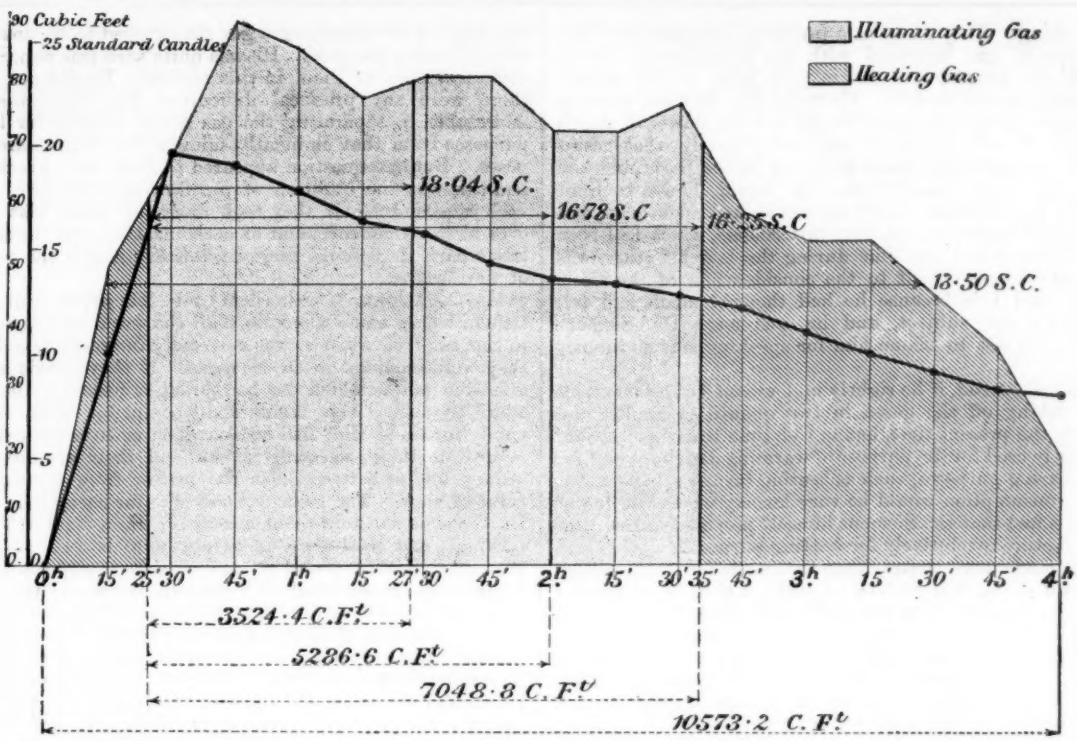
"Tables I. and II. contain the results of experiments made in a bench of seven retorts, of the type of the Compagnie Parisienne, each retort being charged respectively with 100, 110, and 120 kilogrammes (220 lbs., 242 lbs., and 264 lbs.).

Table I. corresponds to a distillation of 4 h. 00 m.
Table II. „ „ „ 4 h. 48 m.

The period of distillation has been divided into intervals of 15 minutes, and the results recorded on each horizontal line refer to the gas produced during the quarter ending the time mentioned on each line.

"In each of the two tables the case of a charge of 110 kilos. (242 lbs.) has been chosen as the standard, and the results have been graphically represented by means of two curves, one in red for the gas produced, and the other in blue for the illuminating power. The line of abscissæ being divided into equal parts, each representing 15 minutes, each ordinate of the red curve gives the gas produced during the preceding quarter of an hour, and the corresponding ordinate of the blue curve indicates the illuminating power of this same gas. The production of the gas has been further divided into two portions—the one destined for illumination, and the other for heating and motive power.

"The gas produced during the first quarter of an hour is generally of low illuminating power, and varies besides with the hygrometric condition of the coal. In the following calculation it has been accordingly classed with the heating gas, and the gas produced during the interval from 15 m. to 2 h. 15 m. of the working has alone been reserved for illuminating purposes:—



I.—*Distillation in Four Hours—Charge*, 110 *kilos.* (242 *lbs.*)

I. Gas produced per 100 kilos. of coal distilled—	Cubic Mètres.	Per Ton Cub. Ft.
1. From 15 m. to 2 h. 15 m.	18·062	6502·32
2. From 0 m. to 0 h. 15 m. and from 2 h. 15 m. to 4 h.	11·308	4070·88
Total	29·370	10573·20

II. Gas produced per 100 cubic mètres obtained—	Cubic Mètres.
1. From 15 m. to 2 h. 15 m.	61·502
2. From 0 m. to 0 h. 15 m. and from 2 h. 15 m. to 4 h.	38·498
Total	100·000

III. Mean illuminating power of the produced gas—	Litres.	In English Stnd. Cand.
1. From 15 m. to 2 h. 15 m.	87·7	16·16
2. From 0 m. to 0 h. 15 m. and from 2 h. 15 m. to 4 h.	128·2	11·05
Mean of the total mixed gas as per calculation	103·3	—
Illuminating power of mixed gas as per direct trial	105·7	13·50

II.—*Distillation in 4 h. 48 m.—Charge*, 110 *kilos.* (242 *lbs.*)

I. Gas produced per 100 kilos. of coal distilled—	Cubic Mètres.	Per Ton Cub. Ft.
1. From 15 m. to 2 h. 15 m.	20·388	7339·68
2. From 0 m. to 0 h. 15 m. and from 2 h. 15 m. to 4 h. 48 m.	9·741	3506·76
Total	30·129	10846·44

II. Gas produced per 100 cubic mètres obtained—	Cubic Mètres.
1. From 15 m. to 2 h. 15 m.	67·673
2. From 0 m. to 0 h. 15 m. and from 2 h. 15 m. to 4 h. 48 m.	32·327
	100·000

III. Mean illuminating power of the produced gas—	Litres.	In English Stnd. Cand.
1. From 15 m. to 2 h. 15 m.	101·1	14·02
2. From 0 m. to 0 h. 15 m. and from 2 h. 15 m. to 4 h. 48 m.	132·4	10·07
Mean of the total mixed gas	111·2	12·77

"It is not proposed to stop at the results obtained by distillation in 4 h. 48 m.—that is, five charges per 24 hours. Experience has proved that the best conditions of working are found in the use of active charges rapidly distilled by raising the temperature of the furnaces.

"From these experiments it results that it would be possible to divide the products of distillation of coal into illuminating gas and gas for heating purposes and motive power. Thus, in place of producing, as is generally done, by means of a distillation of four hours and 110 kilos. (242 lbs.) per retort, a mean result per 100 kilos. of coal distilled of 30 cubic mètres of normal gas, which corresponds to an expenditure of 105 litres to produce the light of a Carcel burner consuming 42 grammes of oil per hour, there may be produced—(1st) about 18·5 cubic mètres of illuminating gas of an illuminating power of 87 litres; and (2nd) about 11·5 cubic mètres of heating and motive power gas of an illuminating power of 128 litres; or, per 100 cubic mètres of gas produced, 61·50 cubic mètres of illuminating gas, and 38·50 cubic mètres of heating and motive power gas.

"This result would be obtained by receiving into separate reservoirs the gas produced during the first 15 minutes, and during the last 1 h. 45 m. of the distillation, and in reserving for illuminating purposes the gas made in the interval of 15 m. to 2 h. 15 m. of the charge from the commencement of the distillation. (Signed) "A. Ellissen.

"*Paris, June* 4, 1881."

Discussion.

Mr. F. W. Hartley said Dr. Siemens occupied such an extremely eminent position, that it required some courage to attempt, in the slightest degree, to challenge any observations he made. However, it was not an unfamiliar project, this division of gas into illuminating and non-illuminating portions. It had been suggested again and again during something like the last 20 years, and several years since it was proposed by a dear old friend of theirs, Mr. Lewis Thompson, in a paper addressed to the Board of Trade; but he (Mr. Hartley) must say that when he saw this paper he thought Mr. Thompson had lost something of his old mental vigour. While it was theoretically true that the gases given off at the beginning and latter end of the charges might be valuable for thermal purposes, they had to consider the question from a practical point of view, and although they could get higher luminosity from the gas given off in the middle, and thereby obtain improved illuminating power, there were other considerations to take into account. One was this: If two sets of mains were required, two sets of meters would also be required in the houses, and two sets of inspectors, or at all events additional superintendence. Therefore, inasmuch as the mains cost from one-third to one-half of the whole gas plant, it followed that the interest on the extra expenditure would have to be paid by one-third of the gas made. Now, seeing that the pressure must be maintained in these mains, during the daytime, upon gas which was of lower gravity than ordinary coal gas, the amount of leakage would be greater than now prevailed under equal pressures. Hence the loss by leakage was likely to be a serious item. Thermal gas could be made cheaply, but if the cost of distribution was added, and the quantity which people were likely to use was taken into consideration, he thought it would be seen at once that any such project was likely, at all events for a long time to come, to be totally unprofitable. He did not say that it might not, under special circumstances, succeed. But for general application it would be an utter impossibility; and even in a large town like Birmingham, which was a special case where gas was more widely applied in the manufacturing arts than perhaps anywhere else throughout the Kingdom, he yet ventured to think it would not answer the purposes of the Corporation to separate the gases into two portions for sale, at the cost of duplicating their mains. In London there were mains enough in the streets already—in fact, far too many, and the efforts of the Companies had been to reduce the number. But, apart from this, he ventured to doubt

another thing. They knew as a practical fact that the thermal power of gas increased with the illuminating power, although the increase was not in proportion to the greater illuminating power or cost. He was sorry that his memory did not serve him with regard to the heating power of marsh gas, or he should be able to say pretty nearly what result might be expected from gases given off at the beginning and at the end of the distillation. He would, however, limit himself to the practical considerations he had mentioned, and would repeat, in conclusion, that this scheme, which had been put before the world any time during the last 20 years, was not one to commend itself to the consideration of the meeting. He said this because he had thought much and felt strongly on the subject, and he was sure Dr. Siemens would be the last to blame him for speaking out so bluntly upon it.

Mr. W. Sugg said, if he rightly understood Dr. Siemens, his idea of taking off the gases in two quantities applied not exactly to the present time, but to the time when gas should be so largely used for the purpose of warming dwellings and for manufacturing purposes, such as heating furnaces, boilers, &c., that the consumption would be very largely increased. It was no doubt a fact that Dr. Siemens himself proposed at one time to manufacture (exclusively for heating purposes) a gas which might be made more cheaply than that made for illuminating; but he said at the time that this could not then be practically carried out, because there was not a sufficiently large demand for such kind of gas. Now suppose gas were more largely used for heating, the demand for gas for this purpose would increase in greater proportion than for illuminating. Thus in a room in an ordinary house lit by two or three burners each consuming 5 feet of gas an hour, if a stove was fixed up which burnt 30 feet an hour there would be something like double the quantity used per hour for the gas-stove than for illumination, and this would go on all day. Therefore it looked as if the demand for gas for heating purposes would in time grow to be a large proportion of that delivered to the public. Then came the question whether the present mains would be capacious enough to supply gas for both purposes, and if it were necessary to lay down a double main for the conveyance of the supply of gas—one for illuminating purposes and the other for heating—it might be worth while to consider the advisability of supplying a gas for heating purposes only from a separate main. As to the question of meters, it would, of course, follow that there must be a meter for both; but it did not follow that there need be two distinct sets of inspectors, any more than where there were at present two meters in one house. With regard to the use of gas for heating purposes, it seemed to him (Mr. Sugg) that if the last part of the charge were better for heating purposes than the middle part of it, which was certainly much better for illuminating, there would be no engineering difficulty in supplying the gas through separate mains, more especially as the gas for heating would be more effectual if delivered at a higher pressure. Another thing to be considered was this: Supposing a large supply of gas were required for heating purposes, when a large building or a number of factories were using it, and they suddenly ceased at six or seven o'clock, would it not be very inconvenient to have such a large volume of gas thrown suddenly on the lighting mains? But if it were supplied separately no such difficulty would ensue. There need not be any trouble in keeping the mains tight, and there could be no doubt that improvements in the jointing of pipes, &c., would follow the extended use of gas at higher pressures; engineering difficulties, therefore, need be no bar. He felt convinced that the public would sooner or later demand a higher illuminating power in their gas. They had gradually crept up from 14 to 17 and 18 candle gas, and possibly they would go on to a still higher illuminating power as the way of burning it was better understood; because in using higher illuminating gas, less was needed, and there would be less heat and fewer products of combustion. If they succeeded in carrying out systems of ventilation in combination with lighting, they might delay the demand for gas of higher illuminating power; but if they did not, this demand must follow on the better understanding of the way of using it.

Mr. A. C. Fraser (Bolton) said some few years ago he was asked by Mr. Coxwell, the famous aëronaut, to provide, for ballooning purposes, a gas of as light a specific gravity as possible. He collected the gas in a small holder by taking off the first produce from the retorts and that given off at the tail end of the charge. Mr. Coxwell was very well satisfied, and made a successful ascent. Later on he had occasion to make another ascent, when, as he had not given any notice, gas of the ordinary quality was supplied, and he (Mr. Fraser) was blamed for supplying a gas that proved to be unsuitable for ballooning purposes. He was quite sure this paper would commend itself to them in this respect. He did not believe there were any practical difficulties but what were surmountable, in separating the gas better adapted for heating purposes from that eminently suitable for illuminating purposes. But one question appeared to have been overlooked; and this was the question of purification, which was one of vast importance. If they took away the gases that passed over at the commencement of carbonization, and those at the latter part, they would very considerably reduce the expenses of purification.

Mr. C. E. Jones (Chesterfield) said this paper, from a gentleman whose name was known all the world over as foremost in the rank of science, was extremely interesting, and for it they were indebted to Dr. Siemens. If they considered the scientific points which he had brought forward, they must admit that they were theoretically complete. But, unfortunately for them, they had to look upon matters not only with regard to their scientific aspect and their symmetry and beauty, but also to consider the matter from a commercial point of view. The great cry now was for cheap gas, and, as Dr. Siemens had told them, electricity was a rival in the field, making great headway. If they were to be in a position to cheapen the production of gas to the public, would not the separation of the gases entail such expenditure on capital account as would make so desirable a reduction in price exceedingly remote? He was of opinion that they would of necessity have to duplicate nearly every part of the gas apparatus to adopt the principle here recommended. They would require connecting valves and diverting pipes in order to control the gas coming off from the retort, so as to separate the first and last from the middle portion of the charge; and this would entail a large capital expenditure. They would also require additional gasholders, and additional distributing plant; and notwithstanding Mr. Sugg was so sanguine as to the result of the system, at present it was a well-known fact that gas dues for heating were proportionately very small. He must take exception to one observation of Mr. Sugg, who said the cry was for increased illuminating power. He held that gas above 20-candle power, with the present burners, was of no practical advantage to the public; but if Mr. Sugg would bring out a burner that would consume 20-candle gas, and give its best photometrical result, without blackening people's ceilings or creating some other inconvenience, it would then be time for the public to demand a higher quality of gas. At present there were no burners in ordinary use capable of consuming it advantageously.

Mr. W. Foulis (Glasgow) did not understand Dr. Siemens to suggest discontinuing the supply of gas for lighting purposes, but that they should enter on a new manufacture, and make gas for heating purposes. If it paid to lay mains for the sale of 100,000 feet of gas for lighting purposes, it would also pay to lay another main to serve 100,000 feet for heating; and if it would pay to supply a meter for lighting gas, it would also pay to supply one for heating gas. The practical difficulty, therefore, was not insuperable, provided there was a demand for the gas. A great deal of talk had taken place about the difference in the heating property of gas of high illuminating power and gas of low illuminating quality, and he had been carrying out a number of experiments on the subject. He still had his doubts about it, as his experiments were not yet complete; but they seemed to indicate that gases of low illuminating power were better suited for heating purposes than gases of high illuminating power.

Mr. W. Carr (Halifax) said they would all agree that the paper had been extremely interesting, and when they heard the discussion that was taking place they found that there was certainly need for a paper on the subject, since there were scarcely two speakers who agreed on the fundamental principles upon which it was based. Mr. Foulis disputed with Mr. Hartley as to the thermal effect of different gases, and also disagreed with others as to the practicability of having two sets of mains. He confessed himself that he thought Dr. Siemens, in his love for what appeared to be an old idea of his, had been somewhat carried away by his enthusiasm, and had lost sight, in some measure, of the practical aspect of the question. He would adopt Mr. Foulis's standard, which was the proper one to take. If it was possible at the present time to supply gas of good illuminating power at 2s. per 1000 feet, would it pay to produce a heating gas and sell it at 1s. per 1000 feet, and lay a separate set of mains for doing so? If there was a demand for it equal to the consumption of illuminating gas, he believed it would pay; but he should say that the con-

venience to the consumer, and the practicability of the whole thing, if taken on another line, would be exceedingly increased. If, for instance, the gases were supplied in bulk, of a given quality, at 1s. 6d. per 1000 feet all round, it would be much better for all parties than having two separate classes, one for heating and one for lighting. From his experience he thought it was quite feasible that gas for illuminating purposes could be supplied at 2s. per 1000 feet, and if it were found profitable to supply gas for heating at 1s. per 1000, it would be quite feasible, from the same works, to supply gas for all purposes at 1s. 6d. per 1000, because the heating gas would be used at times when the illuminating gas was not wanted, and the works would become useful at times when they were now dormant. In this way it would be a great convenience to the consumers, who would not be troubled with duplicate apparatus and separate meters, but would simply have to turn on one tap and take the gas for all purposes for which they required it. Any inquiry they could make which would tend to extend the use of gas for heating or any other purpose than illumination, was one well worthy of consideration, and they were all very much indebted to Dr. Siemens for the excellent paper he had given, which, as had been said, was conceived from a scientific point of view, and he had brought to bear upon it perhaps as much scientific knowledge as any one individual in the country could have done. The gas-fire of which Dr. Siemens had submitted a model was an exceedingly suggestive one. It might not perhaps be the best one of the kind that could be brought out, but it was a novelty—it was a departure on a new line, and would be likely to lead to some tangible result. It utilized two products of gas-works, coke and the gas itself, and it showed a way in which the gas might be used with considerable advantage. For himself, after the experience of the last two or three winters in a northern town, he had almost despaired of ever getting gas extensively used for heating purposes, because, from the gas-fires they had at the present time, it was almost offering an insult to any poor consumers to tell them they ought to have gas-fires when the thermometer was at something like 20° below freezing. A gas-fire as at present constructed was a very poor apology for a fire such as was required for keeping a room at a comfortable temperature; but with coke in combination with gas there might be a fire of some service. In milder climates gas-fires would be useful, but he was afraid they would never come into general use except in some such combination as Dr. Siemens had put before them. He did not know whether Mr. Hartley was quite correct in saying that gases of high illuminating power were of higher thermal power; but he should agree with him that, taken in the aggregate, those gases which had higher illuminating power were generally of high thermal power, because they had all the constituents of gas of low illuminating power with the addition of certain hydrocarbons not possessed by the gas of lower quality, and therefore they must be of higher thermal value. If one began to analyze the gas and take out the heavy hydrocarbons, and leave only the hydrogen, carbonic oxide, and a few of the lower luminous gases (such as marsh gas), gas of high thermal value, which had a low luminous value, would be the result. He was glad to find that Dr. Siemens, who had given so much attention to electric lighting, could also give a little to the improvement of illumination by means of gas. It was a considerable tribute to the value of gas as an illuminating agent that he had done so; and they were indebted to him for his investigations in this direction. For this kind of thing they generally looked to Mr. Sugg, and to one or two other gentlemen who had followed in his steps, and they had been content to accept their investigations as being about all that could be done; but he was glad to find that Dr. Siemens had been able to do something beyond what any of those gentlemen had been able hitherto to accomplish. The statement that he could double the illuminating power of the gas by the adoption of his improved burner, or by the application of the regenerative principle to any other ordinary burner, was a most important matter, and they ought not to lose sight of it.

Mr. Henry Woodall (Leeds) said the consummation they all desired, of cheapening gas, was being brought about to a greater extent than was always perceived. If the price of gas was reduced by 10 per cent., and if the consumption was increased 10 per cent. in the same period, what was the cost of this extra supply to the public? Clearly not a farthing. Many of them had been working under such conditions for years past. Year by year it had been possible to reduce the price of gas by 10 per cent., and never during the same period had they had an increase exceeding 10 per cent. At Leeds during five years the abatements in the price of gas were quite equal to the increase of consumption; therefore there had been an increase of consumption without any increase whatever in the accounts. This all pointed to the development of the present plant and improvement in the processes employed; but suppose they had to erect additional plant, and to bear all the cost of interest and maintenance upon the expenditure, he did not hesitate to say that the extra sale of gas under these conditions would not cost more than 8d. to 9d. per 1000 feet in many towns—the present illuminating power being maintained—and, in many towns the increase could be had for 6d. per 1000 feet. Little by little the public were being made acquainted with this circumstance, and with the way in which these economical principles were operating in their favour, and although they might not, in twelve months, arrive at the condition Dr. Siemens desired, it would inevitably come to this, that on the extra gas they consumed the public would not be required, in the great majority of manufacturing towns, to pay more than 1s. per 1000 feet.

Mr. J. C. Major (Wolverhampton) said he was neither a member of the Association nor a gas manager; but, with the permission of the President, he should like to say a word or two, because he had heard the paper with very great pleasure. He did not regard the question from a manager's point of view; and he did not think gas engineers looked sufficiently to the increase of revenue to be derived from the improved manufacture of residuals. He thought the time might come when the present residuals would be worked as the main object of the distillation of coal, and the gas itself be called the residual. He had been in the trade of a tar distiller something like thirty years, and he remembered the time when they had very much lower heats, with consequently better crude bye-products, for the high heats now used tended to diminish the value and quantity of these products. He thought the right direction to move in was that which Dr. Siemens had indicated, and so encourage a demand for gas for manufacturing purposes. He believed the gas of the future would be gas for heating, especially for manufacturing processes; and if gas companies would call themselves coal distillers, and work in the direction of giving improved so-called bye-products, they would probably do the right thing. Although his interest was wrapped up with that of gas companies, he felt certain the electric light was the light of the future, and therefore it behoved gas managers to look to other things as well as the extension of gas lighting—namely, the production of cheaper gas for heating purposes, and better bye-products.

Mr. G. E. Stevenson (Peterborough) wanted to know how Dr. Siemens or any one else could arrive at the conclusion that heating gas, produced by the method proposed, could be made cheaper than illuminating gas. Dr. Siemens said that two-thirds of the gas out of coal should be taken into one receiver and one set of mains, and be used for illuminating purposes, and the last third should be conducted into a separate set of apparatus, and used for heating purposes. By this method he could not see that the cost of the last third would be any less than that of the first two-thirds. Take it in round numbers that 9000 cubic feet of gas were produced per ton of coal, 6000 feet of this quantity were devoted to illuminating purposes, and 3000 feet to heating; but a ton of coal was carbonized, the cost of which was just the same as before. There was obtained from the 6000 feet a return, in proportion, from the consumers; and also from the 3000 feet again a return. By the use of duplicate mains the leakage would be greater; but even if it would not—if only 10 per cent. were lost—nothing would be gained; there would be produced 9000 feet of gas, and whether it was sold part in one way and part in another, the cost of working a ton of coal would be the same as before. Therefore he did not comprehend what Mr. Henry Woodall had said about the cost being 1s. per 1000 feet. If it could be produced for 1s. per 1000 feet for heating purposes, it could be for illuminating purposes, provided a different material was not used. To his mind the only way in which a cheaper gas for heating purposes could be produced was by using a different material. If a cheaper kind of coal or slack, or any other material, could be used which cost less, then it would be cheaper; but if the same kind of coal was used, and the total quantity of gas divided into two portions, the cost must be the same.

Mr. G. B. Irons (Gosport) expressed his admiration for the paper, which was based equally on sound scientific and practical considerations. Illuminating gas was carburetted hydrogen; it depended for its luminous power on carbon, but for its carrying power on hydrogen. Now, hydrogen had three times as much thermal power as any other substance, and if, in the process of manufacture, they separated the

most luminous from the less luminous and most heating gas, they only followed a very ancient principle in the practice of the butcher, who cut up the prime joints to suit certain customers, and disposed of all the rest (of the animal) for the various purposes and wants of other customers. It was no secret that The Gaslight and Coke Company had determined to let out gas apparatus for heating purposes, and that from investigation they found the annual consumption already, from services and meters fixed specially to supply gas for heating and motive power, beyond anticipation.

Major G. W. Dresser (New York) wished to ask a question on the supposition that the scheme which Dr. Siemens suggested was carried out, and that the means for the distribution of the gas were established, and the process in full operation. The plan proposed only provided for the sale of one-third as much heating as illuminating gas, but when the heating gas business increased beyond one-third of the total manufacture, what were they going to do?

Dr. Siemens said he proposed they first should make one-third, afterwards one-half, and finally two-thirds heating gas, and one-third luminous gas.

Major Dresser said that was just the point. When the thing was established the process would not supply the exact quantity of either gas required, and then how were they going to make up for the deficiency of either gas?

Dr. Siemens: Make more.

Mr. Denny Lane (Cork) said he was very sorry, for the first time, to differ from an authority so eminent as Dr. Siemens. On the tomb of a countryman of his own—Goldsmith—Johnson wrote that there was no kind of writing that he had not touched, and none he had touched which he had not adorned. In science he might say the same thing about Dr. Siemens. Whether they turned to the production of electricity, or its application; to heating, or its application; or whether they turned to the marvellous improvements in the manufacture of steel—on every side they recognized Dr. Siemens as one of the greatest men of practical science that this age had produced. But on the present occasion he (Mr. Lane) was compelled to differ from him, and his attention was called to the subject when Dr. Siemens first proposed the division of gas into two parts, in a lecture he delivered a short time since at Glasgow. He (Mr. Lane) then referred to a very valuable paper read at the last meeting of the Association by Mr. Harrison Veevers, in which he gave the production of gas and the quality of illuminating power in each hour from the first to the sixth. The only thing he (Mr. Lane) regretted about this paper was an omission which could be easily supplied by gentlemen present—namely, that it was principally confined to experiments with Lancashire coal and cannel. His own experience was more confined to Newcastle and Welsh coal. In all these practical questions the important matter of degree must be taken into account. If there was, at the beginning and the end of the distillation, a very large production of gas of high heating and low illuminating power, but in the middle a very large production of high illuminating and low heating power, he would then admit that the proposal before the meeting would be eminently practical; but examining the table he had referred to, it would be seen that the difference between the proportions produced in the middle and the first and last periods of the charge, were not so great as to warrant so important a change. Mr. Sugg had put this question: Supposing that the consumption of gas were very largely increased, would it not then be necessary to lay a second main? He should say, from a practical engineering point of view, certainly not; he would lay a larger main, because if there were taken into account the great amount of friction resulting from using two mains instead of one of the same area, and the large amount of leakage from the number of joints and surfaces more or less permeable, any engineer who had capital at his command would never think of laying two mains in place of one, but would put a larger main in place of a smaller one. He (Mr. Lane) had been much struck with the observations made that evening on the effect of price and the raising of the illuminating power. They all knew that between the interest on capital, the cost of distribution, and the inevitable leakage, a very large proportion of the amount paid by the public was not paid actually for the material supplied to them, but for plant, and, above all, for the plant necessary in distribution, the greater part of which was not used during the daytime. He believed that, taking into account the increased amount of leakage that would arise from a duplicate system of mains, and the increased amount of friction, and the therefore higher initial pressure at the gas-works, and the small difference, according to the experiments of Mr. Veevers, between the middle and the first and last portions of the charge, there would be no practical advantage whatever derived from dividing the product into two parts. He was sorry to differ from Dr. Siemens, but he had no doubt the paper would be of value in setting them all thinking, and endeavouring to ascertain more exactly the difference in the qualities of the gas given off at different stages of a charge.

Mr. W. J. Warner (South Shields) said Dr. Siemens's was a beautiful theory scientifically, and might do a great deal to obviate the evil of which so much complaint was now made—viz., that arising from smoke. But they must remember what had been said as to the duplication and complication of gas apparatus and distributing plant, which must of necessity enhance the cost of manufacture. This was no light matter. Many people required gas of higher illuminating power than the companies at present supplied, and if they could get rid of the portion of gas first drawn off, they could supply gas of higher illuminating power out of the same coal. In some districts where there was pressure put by the public on gas undertakings, it might be necessary so to work; but the general demand would be met, with the resources they at present had at command, by introducing a small percentage of cannel. With regard to the burners which had been brought out, there had been a little reflection cast on the names of Sugg and Hartley; but, if his memory served him right, either one or both those gentlemen were engaged years since with a principle somewhat similar to that which Dr. Siemens had brought forward. They all remembered, too, a gentleman who had made a name for himself in connection with electricity—Professor Faraday—who had also done something for gas-burners, and the object of his burner, which was in use in the Houses of Parliament, was to do what Dr. Siemens did—to heat very highly the atmospheric air on its way to the flame. Some years ago, in connection with the late Mr. Parkinson, he had made a burner somewhat similar to the one before them, with this exception, that there was no gauze around the bottom.

Mr. Corbet Woodall said it seemed to him that the whole value of the suggestion made by Dr. Siemens depended upon the settlement of the question which lay between him and Mr. Hartley—whether or not the gas of lower illuminating value collected at the end of the charge was of greater thermal value than the higher illuminating gas given off in the middle of the charge. Certainly the proposition made by Dr. Siemens was at variance with the ideas most of those present entertained. He had always been of opinion, founded on the observations of careful experimenters, that with the specific gravity of gas free from carbonic acid, the illuminating value went up, and with it the thermal value. If the thermal value of the gas at the later portion was not greater than that of the higher illuminating gas, he could not see any advantage in separating the supply into two channels, while it would entail much extra cost. Mr. Henry Woodall had remarked upon the advantage which accrued to the consumer from the increase of the business of a gas company. It must be borne in mind that what was anticipated in the paper was that the supply of heating gas would be a new business. They were all anxious to encourage in every way the use of gas for such purposes, largely with the idea that they would be supplying in those hours when gas was not used for lighting purposes, and because the more they could increase the use of gas in the daytime the more they would increase the effective value they would get out of their plant. But if, in order to obtain this increased business, they had to lay down duplicate plant, costing just as much as that for ordinary purposes, he thought the time to which his brother referred would be very much thrown back; because they would fail to get the advantage out of the further use of their present plant. Granted that the heating power was not greater in the one case than the other, it seemed to him clear that laying down duplicate systems of mains was simply putting gas companies and the public to great inconvenience, and adding to, rather than diminishing the cost at which the gas of either character could be supplied to the consumer.

Dr. Siemens said he was very well satisfied with the discussion. He did not come there to be flattered, but to put a proposition before the meeting, and have it sharply criticized; and he must say he had obtained what he wanted. If he did not agree with some of the observations which had been made, he might say that he agreed with others; and that, through the discussion which had taken place, at any rate an interest had been excited which sooner or later would produce its fruit. The observations of Mr. Hartley required, perhaps, the most direct reply. He had introduced the question of novelty, and said this was an old proposition, and therefore inferred it was not worth consideration. Mr. Hartley

would have obliged him if he had said who it was proposed the distribution of heating gas to the Board of Trade, and when he did so. For his own part he might say that 18 years ago he vigorously advocated such a plan in Birmingham, and spent between £5000 and £6000 in experimenting upon it, failing only in the House of Lords. He thought a proposition he had been engaged on for 18 years should not be put aside because somebody else had thrown out a hint in a similar direction, probably very much after that time. He brought it forward again in a somewhat modified form now, being as convinced to-day as he was 18 years ago of its value if it were once adopted. The question of the cost of plant, of which Mr. Hartley and several others had made a point, he could not accept. If an engineer wanted to construct a railway, he did not inquire what had been the traffic by the stage-coach during the last 20 years, but what were the capabilities of developing a traffic. Now, with public feeling alive to the importance of heating gas, and with the public clamour for gas of a higher illuminating power, it was for gas companies to supply gas of this higher illuminating power, although it might be at increased cost. Similarly they ought to develop other means of supply, in order to meet the demand for heating gas. This at the present time amounted to a very large proportion of the possible supply, and he felt very certain it would increase with extreme rapidity to ten times its present amount, if consumers did not meet with great difficulty in obtaining it. In his own house he burnt probably as much gas for heating as for illuminating purposes, but he very often had to relinquish the use of it in despair, because in the middle of the day the gas failed, or the supply became so small as to be useless. If heating gas could be supplied at the rate of 1s. per 1000 feet, the consumption of it would be so enormous that it would be a matter of consideration how the demand for it could be met by additional means. The only question which gas engineers should place before themselves was whether, as Mr. Denny Lane put it, to give a mixture of heating gas without illuminating power, and of illuminating gas saddled with an undue amount of heating power, and collect the same into a largely-increased main, taking up the old mains; or whether it would not be better to keep the old mains for the supply of illuminating gas, and put down a second main, at least equal in capacity, to supply heating gas. Suppose the supply of the second main was equal to the supply of the present one, the cost of working expenses would not be increased thereby; there would be double the amount of gas supplied, and the working expenses should certainly be rather less than double. The question of heating *versus* illuminating power had been spoken of by several gentlemen, and although some differed from him as to the question whether the lighter gas had the greater heating power, others took a somewhat different view. He was rather surprised to hear this question discussed at all before such an assembly, because it was well known that hydrogen had a calorific power of 62,000 units per pound, whereas olefiant gas had a calorific power of about 21,000, or, roughly speaking, about one-third of that of hydrogen. Now marsh gas and hydrogen gas went for nothing in illuminating gas—absolutely for nothing, except for heating the atmosphere of the room. It certainly had one useful effect as regarded the seeming interest of the gas suppliers, that it made the gas-meter go round without giving anything to the consumer, but it was heat which he would rather be without. So long as the public were satisfied to receive the ingredients mixed together, it would be simply a question of £ *s. d.* whether or not it would be cheaper for the gas companies to supply both the gases together. He said "No," for this reason, that in many towns—in London certainly—cannel coal was largely mixed in the retorts to bring the illuminating power up to the standard of 16 candles; but he had shown that by using inferior coal without the addition of cannel, 18-candle power could be obtained. In Paris they used coal decidedly inferior to Newcastle, and attained this standard, and therefore there was a practical object for the gas engineer to aim at. If he could supply illuminating gas equal to that produced from a mixture of Newcastle and cannel coal from Newcastle coal alone, he obtained his product from a cheaper ingredient; and, what was of great importance, he also obtained a much better coke, because cannel coal residue spoiled the coke for almost any purpose. What had given rise to the idea that gas of higher illuminating power also possessed a higher heating power was that it was a heavier gas—that in a cubic foot there was more weight. But the value of gas was not in its bulk, but in its low density; each ton of coal produced about 5 or 6 cwt. of gas, and if a portion of it passed away in the form of hydrogen or of marsh gas, of comparatively low specific gravity, surely this was no reason for not supplying it separately, and putting upon it such a value as its calorific power warranted. Weight for weight, substance for substance, the light gas possessed much higher calorific power; although, weight for weight, he was ready to admit that the contrary was the case as regarded illuminating power. Mr. Warner said the burner that had been shown was not new, but was suggested by Faraday. He had the most intense admiration for Faraday, and should be proud indeed to find that Faraday had suggested the same thing; but he must say that the last lecture Faraday ever delivered before the Royal Institution was on this regenerative principle, and that he went with him (Dr. Siemens) to the neighbourhood of Birmingham and elsewhere, to look at the first furnaces he constructed on this plan, and expressed his great delight with the principle involved, but he certainly gave no hint (in his lecture or to himself) that the principle had been borrowed from him. With regard to Mr. Sugg, he knew he had taken a very prominent position in improving gas-burners, and had produced very remarkable results. But Mr. Sugg seemed not to be aware that he had trespassed on his plans; on the contrary, he believed this principle would apply to the beautiful arrangements which Mr. Sugg had already produced. He should be sorry if there were any feeling of antagonism between a man of Mr. Sugg's energy and position and himself. All these improvements should work together to one end—to get from gas a larger result both as an illuminating as well as a heating agent. Nor could he accept it as a reproach to his burner, or to the one now under trial at the Corporation Gas-Works, that similar thoughts had been thrown out previously, for if they had, and they had not been acted upon, it was time they should be brought forward again, and examined on their own merits. He thanked the meeting for the time and attention they had given to his suggestions, and hoped that at any rate they would receive further consideration.

The PRESIDENT said they should all be agreed as to their indebtedness to Dr. Siemens for coming forward with such a very interesting contribution to their proceedings. He had told them he appeared there in two characters—that of a rival and that of a friend—and he (Mr. Hunt) believed they would be disposed to value him as a friend rather than fear him as a rival. He had seen almost every public exhibition of the electric light—including the latest one in the City of London, to which Dr. Siemens had referred—but he must confess that although he had seen much to admire, he had seen nothing to shake his belief in the future of coal gas. It had been stated that the electric light was cheaper than coal gas; but this, he apprehended, had yet to be proved, and for the present they were prepared to challenge the proof. He thought there was no doubt whatever that, on equal grounds, coal gas would be found to be as cheap as the electric light. In the streets generally coal gas had not had a fair chance, and he apprehended the authorities of the City of London had been somewhat more desirous of setting up a rival to coal gas than of permanently improving the illumination of the streets. If they would offer the same facilities to gas engineers to show what gas would do in the public streets of London, as they had offered to eminent electricians, he was quite convinced that, at all events, gas would not come off second best; and he needed no other weapons for such a contest than those with which Dr. Siemens and his eminent brother had furnished them. They had seen before them what coal gas was capable of producing under the magic art of Dr. Siemens, and the burners they had used at the Windsor Street Gas-Works were of at least equal illuminating power in proportion to the consumption of gas. He should be very pleased if any gentlemen who were interested would call at night and see these burners lit up in their full splendour, when he thought their faith in coal gas would be very much increased. Turning now to Dr. Siemens as a friend, the proposal put before them for separating gas less valuable for illuminating purposes was described by Mr. Hartley as an old one. He did not think Dr. Siemens quite caught from Mr. Hartley who it was proposed it; it was their old friend Mr. Lewis Thompson, he believed about 20 years ago.

Mr. HARTLEY stated that when he said about 20 years ago, he did not know that Dr. Siemens had been the author. He knew that it had been proposed about that time since. It was about 10 years ago that the letter he referred to was sent by Mr. Lewis Thompson to the Board of Trade.

The PRESIDENT said in his address that morning he referred to a letter which Dr. Wallace addressed to the JOURNAL OF GAS LIGHTING only a few months ago, making this very proposal, and although it was not original on his part, it came rather in the light of a novelty; but the objection put by Major Dresser was the one which had been in his mind when he described the proposal as impracticable. If a distinction

were made between heating and lighting gas in the manner proposed, then two consumptions would have to be dealt with; and while on the one side they would be fixed by the illuminating power of the gas they had to supply, and also by the consumption of it, on the other side they would be committed to a consumption of heating gas. The demand for the two kinds of gas could not always be balanced in accordance with the make, or they would be compelled to have recourse to some other agency to supply the deficiency on the one side or on the other. Another drawback was this: The two-thirds lighting gas which Dr. Siemens would produce would have an illuminating power of 18 candles, and this would have to be supplied at a somewhat advanced rate in order to enable them to supply the one-third heating gas (which would have an illuminating power of about 11 candles) at a lower price. He very much questioned whether, if a consumer had the choice between 18-candle gas at a high figure, and 11-candle gas at a low one, he would not choose the latter, and they would therefore find a very much greater demand for the lower-priced gas than for the higher, and thus another difficulty would crop up. Then came the question about the heating power of the gas. Dr. Siemens had told them that the heating power was very much greater than that of olefiant gas; but this was for equal weights, and all their calculations were based on volume, and must be reduced to weight before they could be worked out on any practical basis. He thought Mr. Henry Woodall's remarks were not quite apprehended. What this gentleman meant was that they were going in the direction of cheaper gas, and if they could succeed, by increasing their business, in supplying it at a much lower figure, they would do away altogether with the necessity, even supposing such a necessity to exist, of supplying two gases; and he quite agreed with him. He thought their efforts should be directed more and more to the cheapening of the gas supplied at one uniform quality, and at as low a figure as possible. But however much they might be disposed to differ from Dr. Siemens with regard to these matters, they all owed him a deep debt of gratitude for coming amongst them, and as he was not likely to be present at the end of their proceedings, it would be only right that they should depart from their usual custom to accord him now a cordial vote of thanks for his paper.

This proposal was carried by acclamation.

(III.)

THE ADVANTAGE OF THE REGENERATIVE SYSTEM OF HEATING.

By Mr. G. E. Stevenson, of Peterborough.

In a paper entitled "Regenerative Furnaces as applied to the Heating of Retorts," read before the Association last year, the subject was considered chiefly in reference to a certain form of furnace recently patented on the Continent and in England. In the present paper I propose to deal more generally with the principle of the regenerative or gas furnace, and to demonstrate theoretically, as well as on practical grounds, the advantage which this method of heating possesses over that of the direct combustion of fuel.

Whether it was the necessity of obtaining an intense and uniform heat, or the desirability of economy in the fuel used, which first led the inventor of the regenerative system to apply his energy and genius in this direction, I am not aware; but assuredly one of the first thoughts present to his mind must have been the fact of the absence of control over the process of combustion in ordinary furnaces, and the necessity, not only of ascertaining what actually takes place in a furnace, but of being able to regulate the chemical action going on, and thus ensure a uniform result having some approximation to that which should theoretically follow the consumption of a given quantity of fuel.

The key to the process that takes place in the interior of a furnace is the analysis of the effluent gases. From such analyses it can be ascertained whether the combustion has been complete, or whether unburnt gases are being permitted to pass away not utilized. Also, if free oxygen be found to be present in the waste gases, it is known that too much air has passed through the furnace, and by quantitative analysis the extent and proportion of this excess may be ascertained. The usefulness of such analyses, even in the case of an ordinary furnace, must be evident; but it is only when applied to the control of a gas furnace that their full importance becomes manifest.

In calculating the heat-energy developed in a furnace, we proceed, as is well known, upon the basis of a unit of weight of the substance undergoing combustion developing a certain number of what are called "heat-units," by which we mean so many of the same units of weight of water raised one degree in temperature. The English unit of heat is 1 lb. avoirdupois raised one degree Fahrenheit.

Complete and reliable experiments have been made by eminent scientific chemists to determine the heat-effect of the combustible elements, and, provided we know the composition of any combustible material, we are in a position to calculate the heat which that material will develop. The following table gives the principal combustible elements with the proportion of oxygen required for their combustion, and the number of British heat-units which they develop according to Favre and Silbermann:—

Table I.

Combustible.	Oxygen.	Product.	Heat Developed.
1 lb. hydrogen and	8·000 lbs. oxygen	produce 9·000 lbs. steam, and develop	62,032 units.
1 lb. carbon	1·333 lbs. oxygen	2·333 lbs. carb. oxide	4,453
1 lb. carb. oxide	0·571 lb. oxygen	1·571 lbs. carb. acid	4,325
1 lb. carbon	2·666 lbs. oxygen	3·666 lbs. carb. acid	14,544

When we are dealing with the chemical constitution of the fuel, weight for weight, the above table forms a suitable starting point for estimating the value of the fuel for heating purposes; when, however, we require to know what has taken place through the analysis of the effluent gases after combustion, we need a table based upon a unit of volume instead of weight. The following table is constructed on the basis of an equal temperature of 32° Fahr., and a barometric pressure of 29·922 inches of mercury:—

Table II.

Product.	Combustible.	Oxygen.	Heat Developed.
1 c. ft. steam is prod. from	1 c. ft. hydrogen and	½ c. ft. oxygen with develop.	327 units.
1 " carb. oxide	0·0314 lb. carbon	½ " oxygen " "	139 "
1 " carb. acid	1 c. ft. carb. oxide	½ " oxygen " "	318 "
1 " carb. acid	0·0314 lb. carbon	1 " oxygen " "	457 "

This table gives an insight into certain relationships, the existence of which is not indicated by the former table. First we see that the combustion of hydrogen and likewise of carbonic oxide result in an equal volume of gaseous products (leaving out of consideration the expansion due to increase of temperature), and that the heat developed per unit of volume is very nearly equal. We also see that a cubic foot of carbonic oxide contains the same weight of carbon as a cubic foot of carbonic acid, and that the production of one cubic foot of carbonic acid by the combustion of a cubic foot of carbonic oxide absorbs exactly as much oxygen as the production of a cubic foot of carbonic oxide from carbon. In the combustion of hydrogen to water, of carbon to carbonic oxide, and of carbonic oxide to carbonic acid, in each of these three cases the gaseous product has a volume double that of the oxygen consumed; when, however, carbon is burnt direct to carbonic acid, the oxygen consumed is equal in volume to the carbonic acid produced. From these facts we are enabled to determine the composition of the products of combustion, provided that no oxygen be contained in the fuel itself.

The atmospheric air consists, as you are aware, of 79 per cent. of nitrogen and 21 per cent. of oxygen by volume. When air is consumed in supporting combustion, the nitrogen remains unchanged, but the oxygen becomes replaced by the products of combustion, carbonic acid, carbonic oxide, aqueous vapour, &c. These gases may be present in different proportions, but the sum of them will be such that the oxygen contained by them will be proportionate to the accompanying nitrogen in the ratio of 21 to 79. If, however, free oxygen be present, this must be added to that contained in the products to maintain the above proportion in relation to the nitrogen. In the case of the complete combustion to carbonic acid, if this be theoretically perfect there will result 1 cubic foot of waste gases for every cubic foot of air entering at the furnace, and these gases will consist of 21 per cent. of carbonic acid and 79 per cent. of nitrogen.

Let us now take two analyses of waste gases from an ordinary retort-setting, published by Dr. Bunte, the chemist at the Munich Gas-Works. No. 1 is taken when the fire had burnt down previous to clinkering, and No. 2 when the furnace was properly filled and doing full work.

Analysis No. 1.		*Analysis No.* 2.	
Carbonic acid . .	8 per cent.	Carbonic acid . .	16 per cent.
Free oxygen . . .	12 "	Free oxygen . . .	4 "
Nitrogen	80 "	Nitrogen	80 "

It will be seen that in analysis No. 1 there is 12 per cent. of free oxygen as against 8 per cent. of carbonic acid, and therefore as the carbonic acid is equal in volume to the oxygen it has replaced, 2½ times the quantity of air theoretically necessary has passed through the furnace. By the help of Table II. we can easily calculate the heat developed per cubic foot of the waste gases produced. It is only necessary to multiply the number of heat-units given in the table for the product by the percentage contained in each cubic foot of the mixed

gases. Thus, for Analysis No. 1, we have 0·08 × 457 = 36·56 units, and for Analysis No. 2, 0·16 × 457 = 73·12 units, or exactly double that of No. 1, corresponding to the double proportion of carbonic acid present.

To ascertain, with any degree of accuracy, the intensity of heat developed, it is necessary to go back to the weight of the carbon consumed and the quantity of air used per pound of carbon. In Analysis No. 1 we have $2\frac{1}{2}$ times the necessary quantity of air; therefore, as 1 lb. of carbon requires for its complete combustion, in round numbers, 12 lbs. of air, we have 12 × 2·5 = 30 lbs. of air passing through the furnace per pound of carbon consumed. From these 30 lbs. of air the 1 lb. of carbon will abstract 2·666 lbs. of oxygen to form carbonic acid, leaving 3·999 lbs. of oxygen free, accompanied by 23·335 lbs. of nitrogen. The pound of carbon will develop, according to Table I., 14,544 units of heat by its combustion. Of this, however, at least 10 per cent. will be dissipated by radiation from the fire-grate and walls of the furnace, leaving 13,090 units for heating the products of combustion. A certain amount of heat will be absorbed in raising the temperature of the gases, which will be dependent on their specific heat. The specific heat is that proportion of heat required to raise the gases one degree in temperature, water being raised one degree by one unit of heat. The specific heat of the principal gases with which we have to do is given by Regnault as follows:—

Oxygen	0·2182	Carbonic acid	0·2164
Hydrogen	3·4046	Carbonic oxide	0·2479
Nitrogen	0·2440	Aqueous vapour	0·4750

Atmospheric air, 0·2379.

By the combustion of 1 lb. of carbon are produced 3·666 lbs. of carbonic acid, and to raise this quantity one degree absorbs 3·666 × 0·2164 = 0·793 unit of heat. Similarly the accompanying free oxygen, which in Analysis No. 1 we found to be 3·999 lbs., absorbs 3·999 × 0·2182 = 0·872 unit, and the 23·335 lbs. of nitrogen absorb 23·335 × 0·244 = 5·693 units; therefore—

Carbonic acid	0·793 units
Oxygen	0·872 ,,
Nitrogen	5·693 ,,
Total	7·358 units

will be absorbed per degree of temperature. Dividing by this the number of heat-units = 13,090, we get an initial temperature for the products of 13,090 ÷ 7·358 = 1779° Fahr. In Analysis No. 2, in which the excess of air amounts to one-fourth of the theoretically requisite quantity, we should get, proceeding by the same method, an initial temperature of 3459° Fahr. The details of the calculation are as follows:—

Combined oxygen				2·666 lbs.
Free oxygen				0·666 ,,
Nitrogen				11·668 ,,
Air passing through furnace per pound of carbon consumed				15·000 lbs.
Carbonic acid	3·666	× 0·2164	=	0·793 units.
Oxygen	0·666	× 0·2182	=	0·145 ,,
Nitrogen	11·668	× 0·2440	=	2·846 ,,
Total				3·784 units.

13,090 ÷ 3·784 = 3459° Fahr.

To maintain the retorts at a uniform heat, the products of combustion must not be cooled by contact with them to a lower temperature than that at which the retorts themselves are to be maintained, which temperature, for the effective carbonization of coal, should not be less than 1500° Fahr. The heat available for carbonization is, therefore, the surplus heat over and above this temperature. In the case of Analysis No. 1, we have 1779° − 1500° = 279° surplus, or barely 16 per cent., and in the case of Analysis No. 2 we have 3459° − 1500° = 1959°, or 56 per cent. of the total quantity of heat.

These examples of ordinary furnaces suffice to show the disadvantage of any system by which the process of combustion cannot be equally maintained. At the time when the furnace has burnt down, as in Analysis No. 1, one of two things must occur—either the carbonization of the coal must be suspended, or the heat of the retorts must diminish; there is sufficient heat to maintain the retorts alone at the required temperature, but hardly any margin for work to be done in them. In Analysis No. 2 there is a margin of 56 per cent., and a higher result than this is not to be expected from ordinary retort-settings.

Having now seen the important bearing of the analyses of the effluent gases from a furnace or retort-setting upon the process of combustion, let us proceed to examine the principle of the generator, or gas furnace. In this method of heating the process of combustion is divided into two stages—first, we have incomplete combustion, or the production of combustible gas; and, secondly, complete combustion and the utilization of this gas in the oven itself. First, there enters at the slit or grate of the generator a certain quantity of air, which consumes a portion of the fuel, producing carbonic acid gas, with its accompanying development of heat. The gases, consisting of 21 per cent. of carbonic acid and 79 per cent. of nitrogen, then ascend through the stratum of unburnt fuel, taking from it another equivalent of carbon, and the carbonic acid becomes reduced to carbonic oxide. The initial temperature at the slit of the generator will be about 4400° Fahr., allowing 10 per cent. loss by radiation from the slit and surrounding brickwork. The carbonic oxide possesses double the volume of the carbonic acid originally produced, for not only is the 21 per cent. of carbonic acid reduced, but also 21 per cent. of carbonic oxide is formed from the fuel. The heat effect of 1 lb. of carbon burning to carbonic oxide is given in Table I. as 4453 units. The product of 1 lb. of carbon thus consumed is 2·333 lbs. of carbonic oxide, accompanied by 4·667 lbs. of nitrogen. The carbonic oxide has a specific heat of 0·2479 unit; therefore, 2·333 × 0·2479 = 0·578 unit of heat will be rendered latent in raising the carbonic oxide, and 4·667 × 0·244 = 1·138 units in raising the accompanying nitrogen one degree in temperature—together 1·716 units. Dividing by this the 4453 units developed, we get 2600° as the temperature of the gases in the generator after the carbonic acid has all been reduced, and supposing no loss to have occurred through radiation. If the generator be constructed separate from the retort-setting, there will be a loss on this account of something like 20 per cent. before the gases reach the point of secondary combustion, and the temperature will be reduced to about 2000° Fahr.

We now come to the secondary combustion of the carbonic oxide to carbonic acid. From 1 lb. of carbon is produced 2·333 lbs. of carbonic oxide, and by the further combustion of this quantity of carbonic oxide, 4325 × 2·333 = 10,091 units of heat will be developed, making up the total quantity produced by 1 lb. of carbon burning to carbonic acid. The oxygen required to consume this quantity of carbonic oxide is exactly equivalent to that required in the primary combustion of the 1 lb. of carbon to carbonic oxide—viz. 1·333 lbs. If no excess of air be supplied, the calorific intensity produced will be found in the following manner, supposing the carbonic oxide not previously heated:—

Heat absorbed in raising the Gases 1° in Temperature.

3·666 lbs. of carbonic acid	×	0·2164	=	0·793 units.
9·334 lbs. of nitrogen	×	0·2440	=	2·277 ,,
13·000	Total			3·070 units.

10,091 ÷ 3·070 = 3287° Fahr. But the gases arrive at the burners with a temperature of 2000°, this being the result of the 4453 units of heat developed in the primary combustion, less 20 per cent. loss through radiation = 3563 units. These must be added to the 10,091 units produced by the secondary combustion, making a total of 13,654 units, and the resulting temperature is 13,654 ÷ 3·070 = 4447° Fahr. In this case we get a surplus heating power equal to 66 per cent. of the total quantity developed.

Having thus followed the process of the gas production and its subsequent utilization, we are now in a position to see something of the advantage of the regenerative system of heating. It will be evident that it is easier to approach theoretical perfection in practical working by using the double process of producing a combustible gas and afterwards burning this gas under the retorts, than by the ordinary method of firing, because we supplement a deficiency of air in the first instance by supplying it in the second process, where it is completely under control. There is less danger of an excess of air being admitted, for, when dealing with the solid fuel, there must of necessity be less air admitted than is requisite for complete combustion, and when we come to deal with the fuel in a gaseous condition, the intimate mixture of air and fuel is easily attained. In practice the results do not, of course, come up to theory, but they approach far more nearly to it than by the old system, as the following analysis of waste gases from a retort-setting heated by a generator furnace will show:—

Carbonic acid	19·0 per cent.
Oxygen	1·5 ,,
Nitrogen	79·5 ,,

But we have not yet touched upon the chief advantage to be obtained from the use of the gas furnace. Hitherto we have considered only the process of combustion; we have now to consider the question of "regeneration." By the regeneration is understood the heating of the air supplied to the furnace, and the utilization for this purpose of the heat contained in the products of combustion after they have left the object to be heated, and passed away towards the chimney flue. The question of regeneration assumes a position of

importance simultaneously with the adoption of generator furnaces. Under the old system, it is impossible to avail ourselves of this advantage to any appreciable extent. Hot air cannot be introduced under a fire-grate without melting the fire-bars, added to which it is well-nigh impossible to close up the grate from the external air, as the necessities of clinkering and clearing away the ashes render constant access to the fire-grate imperative. It will presently be shown that the primary air supply may be partially heated in the case of a slit generator, but I am not aware that any one has found it practicable with a grate furnace. With the generator furnace, however, the secondary air supply used for the combustion of the carbonic oxide may be heated to any extent, and *the whole of the heat taken from the waste gases and transferred to the air entering at the burners is rendered available for useful effect.*

In determining the value of the regeneration, we have to take into consideration—first, the quantity of air that passes through the regenerator per pound of fuel used; and, secondly, the temperature at which it issues from the regenerator and arrives at the point of ignition. As regards the quantity of air, 12 lbs., in round numbers, are required for the complete combustion of 1 lb. of carbon, of which, as has already been shown, one-half is required for the primary, and one-half for the secondary combustion. The specific heat of atmospheric air being 0·2379, the 6 lbs. of air, forming the secondary supply will, if heated 1000°, take up 1000 × 6 × 0·2379 = 1427 units of heat, and deliver them back again to the retorts. Taking the hypothetical case of the generator furnace in which 13,654 units per pound of carbon were brought to bear on the retorts, we should have with air heated 1000° an increment of more than 10 per cent., or altogether 15,081 units of heat per pound of carbon consumed. This amount of heat would produce an initial temperature of 4912°, and, as the gases leave the retorts at 1500°, the percentage of useful effect would be nearly 70 instead of 66 without regeneration.

I have put the temperature of the effluent gases at 1500° Fahr., as this corresponds pretty well with the general working of retorts; but you will easily perceive that, by applying the principle of regeneration, the temperature of the gases may be much greater on leaving the retorts, and yet no loss result therefrom. With the ordinary method of heating there is a limit to the temperature at which the retorts can be worked with economy, because the higher the temperature of the effluent gases in proportion to the initial temperature of combustion, the less the proportion of useful effect produced. With the regenerative system, on the contrary, it matters not how hot the gases are when they leave the object to be heated, provided the heat is afterwards withdrawn from them and transferred to the air supply. The process is accumulative, and thus a high heat may be maintained without waste of fuel or destructive draught.

There is still another element in the process of combustion in the generator furnace, which has lately been brought into prominence, and that is the use of steam. If steam be introduced into a furnace heated by coke, the steam becomes decomposed into its elements, the oxygen being absorbed in the combustion of the fuel, and the hydrogen set free and rendered available for combustion at a later stage of the process. As much heat is absorbed and rendered latent by the dissociation of the hydrogen and oxygen as is afterwards redeveloped by the combustion of the hydrogen, and thus a certain proportion of heat development is transferred from the primary to the secondary combustion.

Assuming that for every pound of carbon consumed, half a pound of steam were introduced into the generator, we should have 1 lb. of carbon producing 2·333 lbs. of carbonic oxide, and developing 4453 units of heat, and ½ lb. of steam resolved into 0·055 lb. of hydrogen and 0·445 lb. of oxygen. The dissociation of the hydrogen and oxygen would absorb 62,032 ÷ 18 = 3446 units of heat, and this deducted from the 4453 units developed by the combustion of the carbon to carbonic oxide would leave 4453 − 3446 = 1007 units of net sensible heat effect. For the combustion of the carbon 1·333 − 0·445 = 0·888 lb. of oxygen must be supplied by the atmospheric air, this amount being accompanied by 0·888 × 3·5 = 3·108 lbs. of nitrogen. In raising the gases one degree, therefore, will be absorbed—

Carbonic oxide . . .	2·333 lbs.	×	0·2479	= 0·578 units.
Nitrogen	3·108 lbs.	×	0·2440	= 0·758 „
Hydrogen	0·055 lb.	×	3·4046	= 0·187 „
Total				1·523 units.

Allowing 20 per cent. loss by radiation, as before, we have 1007 − 202 = 805 ÷ 1·523 = 528° Fahr. as the temperature of the combustible gases. In the secondary combustion there will be 2·333 lbs. CO + 1·333 lbs. O = 3·666 lbs. CO_2 with development of 10,091 units, and 0·055 lb. H + 0·445 lb. O = 0·500 lb. H_2O, with development of 3446 units—together, 13,537 units; added to which we have 805 units from the primary combustion, making in all 14,342 units. At the termination of the process the proportion of the gases will be the same as before, with the addition of half a pound of steam; therefore—

3·666 lbs. carbonic acid		×	0·2164	= 0·793 units.
9·334 lbs. nitrogen		×	0·2440	= 2·277 „
0·055 lb. steam		×	0·4750	= 0·237 „
Total . .	. . .			3·307 units.

14,342 ÷ 3·307 = 4336° Fahr. will, therefore, be the temperature produced.

We see that by the use of steam the temperature in the generator is very considerably reduced, and the final temperature is also somewhat lower; the total amount of heat developed is, however, the same for the carbon contained in the fuel with the addition of that due to the hydrogen of the steam. The total number of heat units is spread over a larger volume of gaseous products, with a consequent reduction in temperature. If the regeneration be thoroughly carried out, some advantage may be obtained with the use of steam; but without regeneration an actual loss will be incurred, through the increased volume of the effluent gases and the reduced initial temperature.

When it is considered what a reservoir of heat is contained in the waste gases of a retort-setting, the idea of heating not only the secondary but also the primary air supply is forcibly presented to the mind. That there is much practical difficulty in applying such a method to a grate furnace has been abundantly proved, but it might be applied to a slit generator, and would probably greatly facilitate the melting of the clinker and its removal from the slit of the generator.

In the design shown in the accompanying illustrations,* an attempt has been made to apply such an arrangement in the place of the small subsidiary grate which the original Liegel furnace possesses below the slit. In the experience already gained in this country with this kind of furnace, the small grate has not been found to work well, and has been abandoned. It is difficult to regulate the quantity of fuel burning on the grate so as to maintain a uniform heat from it, and it is found preferable to work with an increased draught, and thus melt the clinker by the heat of the furnace alone. This excess of draught is prejudicial to the economy of fuel, and causes to be formed in the generator a larger proportion of carbonic acid than ought to exist. By heating the primary air supply, I believe that a much less draught will be sufficient. The ashpit is intended to be closed up, and only a small trap-door opened when the slit requires clinkering, and with such an arrangement much less heat than at present will be lost by radiation from the slit.

In this design the regenerative principle is much more fully carried out than hitherto. The generator is brought forward clear of the setting, and a greater space rendered available for regenerating flues. The waste gases traverse the central flues in the groups on either side of the setting, while the smaller channels are devoted to the secondary air supply. The primary air supply is conducted through the lowest channels, and comes in contact with the waste gases after the greater portion of their heat has been absorbed by the secondary air supply. These flues are intended to be constructed of fire-clay tiles, tongued and grooved at the joints so as to prevent leakage; and as there are two layers of such tiles in the roof and floor of each set of flues, the upper layer breaking joint with the lower, it is not likely that much of the air will find its way amongst the waste gases. The setting was designed for a large works in the North of England, but its adoption has been postponed.

In the year 1877 a Committee was appointed by the German Association of Gas and Water Engineers to experiment upon generator furnaces. The Committee spent more than a year in experimenting with different kinds of coal, both with and without the use of steam, and a full report was published, a reproduction of which would be impossible in a paper such as this. The experiments, however, led to the following conclusions:—1. The stronger the draught with which the generator is worked the greater the percentage of carbonic acid contained in the gas produced. This varied in the case of the slit generator from 1·9 per cent. to 5·8 per cent., the highest draught being about 0·35 inch. 2. The greater the percentage of carbonic acid the higher the temperature in the generator, and consequently the greater the loss of heat by radiation.

* See pp. 1154-55.

In the experiments with steam it appeared that a *greater* draught was required to produce the same result than with air alone; the temperature in the generator was, however, less than when no steam was used. The proportion of steam which could, without detriment to the ultimate heat-effect, be used, varied, according to the different kinds of coke burnt, from 50 to 80 per cent. of the weight of the coke, and the average analysis of the generator gases was as follows:—

Carbonic acid	9 per cent.
Carbonic oxide	19 „
Hydrogen	10 „
Nitrogen	62 „

In concluding this paper, I venture to hope that the importance of the subject will be thought sufficient excuse for occupying the time of the Association at so great a length. It is not a question, primarily, of any particular form of furnace, but of a principle, the value of which has long been recognised in other branches of the engineering profession, and is now rapidly becoming applied in other countries for heating retort-settings. It is to be hoped that the difficulties in the way of introducing it into our own works may be speedily removed, and ourselves saved the reproach of being behindhand in the application of scientific knowledge.

Discussion.

Dr. SIEMENS said he had listened with much pleasure to the paper. He was glad to see that the chemical principles upon which combustion generally, and more particularly combustion in the regenerative gas furnace, depended, were being so thoroughly investigated; and from the attention paid to the paper he perceived that gas engineers took a deep interest in these questions. The first furnace applied to gas retorts on the regenerative principle was one erected in London by the Chartered Gas Company at their Goswell Road station in 1862. It answered its purpose very well. It heated two beds of retorts in a satisfactory manner, and with economy; but the reason why it was not extended at this station was on account of want of room. The Company decided to increase the number of retort-beds, and they did not see where to place the additional gas producers. Moreover, some difficulty was experienced in providing room for the regenerators below the furnace. It was at the Paris Gas-Works in the following year that he first met with conditions favourable to the introduction of the system. The Paris Gas Company had continued to a large extent the use of the regenerative system ever since; and he believed had reaped considerable advantages. The author of the paper had pointed very ably to all these advantages, except that he did not lay stress on the greater output from a bed of retorts when heated on the regenerative system; and this he (Dr. Siemens) looked upon as perhaps the most important point of all. In applying the regenerative mode of heating, one additional retort could be placed in each bed, and the whole of the retorts could be heated uniformly. He did not say they were to be heated to a higher temperature, because this would involve danger to their permanence; but if they could be heated practically uniformly, it implied something more than heating them to a higher temperature, because the material being all brought up to the highest point of heat which it could permanently bear, and not being subjected to unequal expansion, would produce the maximum effect during the greatest length of time. This was, therefore, one of the greatest recommendations of the regenerative mode of heating. The author of the paper also called attention to the importance of aiding the production of gas, especially when coke was employed, by the use of steam, and said this was a recent introduction; but such was hardly the case, because the retorts in Paris were worked by gas produced with coke, with the addition of water below the grate to aid in the decomposition of the fuel. With regard to this question of the introduction of water—water gas as it had been called—a great deal of misconception had arisen, and very extraordinary statements had been made, evidently put forward by gentlemen who had not thoroughly understood the question. If gas were developed from wet coal, it would not be at all desirable to introduce water, because it would only prevent the attainment of the high temperature which was essential to produce the re-conversion of the carbonic acid into carbonic oxide. Therein consisted the danger of the use of water to any great extent. Of course, by the decomposition of water and carbon into hydrogen and carbonic oxide, no positive gain of heat could be expected. The number of units of heat-energy which could be given out by the combustion of these gases was necessarily involved in the decomposition of the water and carbon which were required to produce them; and all the good to be expected from the process was to transfer the heat from the gas producer to the furnace. Instead of having a hot gas producer, there was a cool gas producer, and the sensible heat which there was in the first place was changed into latent heat, and this heat was re-developed in the furnace. If the gas had to travel a considerable distance, the advantage of the employment of as much water as possible in the decomposition of the fuel was manifest, because the sensible heat of the gas would be lost in transit, and in this case the hydrogen and carbonic oxide produced by the decomposition of water would be re-delivered to the furnace. All these principles had been well understood by the author of the paper. With regard to the specific plan he had brought forward, he (Dr. Siemens) had no doubt it could be made to work satisfactorily; but he saw that it inherited some of the difficulties with which he formerly had to contend. It involved a considerable depth of brickwork below the retort-settings, and it would be desirable to adopt a plan whereby this depth could be materially reduced. Also with regard to the form of the gas generator with a slit, which recommended itself by its apparent simplicity and the want of stoking, if it could be ensured that the earthy matter contained in the fuel always ran out by itself in the liquid condition, it would work well, but he apprehended some difficulty would be met with in this direction. Some fuel contained earthy matters which resolved themselves into fusible slag, but others contained mostly silica, which would not form such a fusible slag, and would be liable to choke up the slit with clinker. If the air entering the slit could be heated, of course the difficulty would be diminished; but, on the other hand, another difficulty would arise—that of a closed ashpit. He had worked with closed ashpits to a considerable extent, but had seen good reason to abandon them, because it was very inconvenient to have to open a door before entering the ashpit for the purpose of adjusting the fuel and removing clinker.

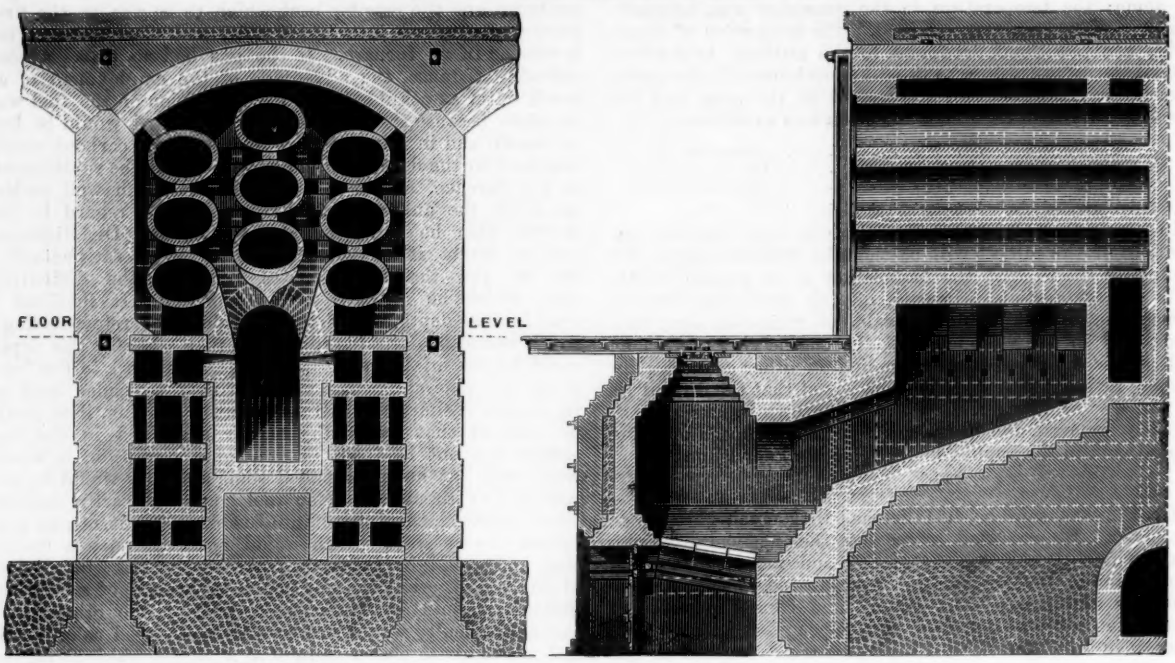
Mr. H. PEATY (Longport) said if gaseous fuel were to be the fuel of the future, gas managers could not do better than use it themselves, and thus advertise it while deriving benefit from its use. One point was thoroughly proved, which was that gaseous fuel was quite able to do all that was required to produce the temperature necessary for carbonization. In fact, it went a little too far, and produced heat enough to melt down the furnace. Gaseous fuel, however, could be applied without regeneration. What they required was not a blast furnace to reduce ores, but only a heat of about 2000° Fahr., and the advantage stated by Mr. Stevenson was only the addition of about 10 per cent. to the thermal effect by regeneration. Therefore, gaseous fuel could be introduced under the retorts in the same way as, if they were going to supply the public, it could be introduced into mains. If this view were correct, they could do without so complicated an apparatus underneath the setting, and thus save the expense of building it. A very small aperture underneath the setting would suffice to introduce the gas, and produce the desired combustion, whilst the cost of an apparatus such as had been described would be very great, there being a regenerating furnace for each set of retorts, whereas by supplying gaseous fuel by mains, one generator could be set up in any part of the yard. There were plenty of gas generators in the market, such as Siemens's, Wilson's, or Strong's, which he considered the best, as there was such a large proportion of hydrogen gas without the deteriorating effects of nitrogen, which must go on with Siemens's or Wilson's.

Mr. F. W. HARTLEY said he had not had any practical experience of the regenerative system, but had watched its progress, and seen a good many furnaces in operation; and certainly the principle on which they were based must attract the attention and admiration of every man who wanted to use fuel under the most economical conditions. There could be no question that a more equal heat was obtained in the setting, and the highest economy of fuel. He wished to correct an expression of the last speaker, that gas could be as well made at a considerable distance from the retort-settings, and conveyed to the furnace, because under such circumstances they would lose temperature and heat by storing the gases, and afterwards delivering them to the furnaces. The great advantage of this system in retort-settings seemed to be that the gases, as soon as generated, were delivered red-hot for combustion.

Mr. PEATY desired to add that he did not think so intense a heat was necessary, and that when warmed up again on entering the furnace it would be sufficient for all that was required.

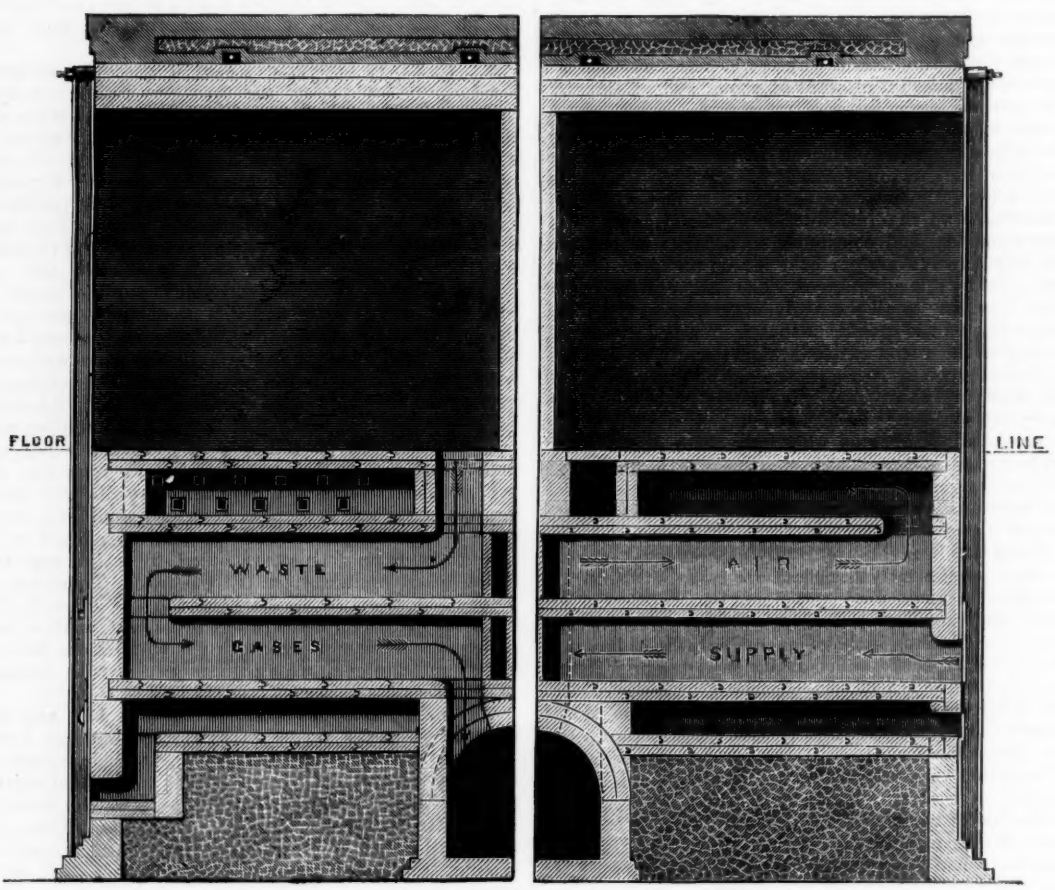
Mr. T. B. BALL (New Wortley) said they were all willing

LIEGEL-STEVENSON REGENERATIVE GAS FURNACE FOR RETORTS.



TRANSVERSE SECTION.

HALF LONGITUDINAL SECTION.

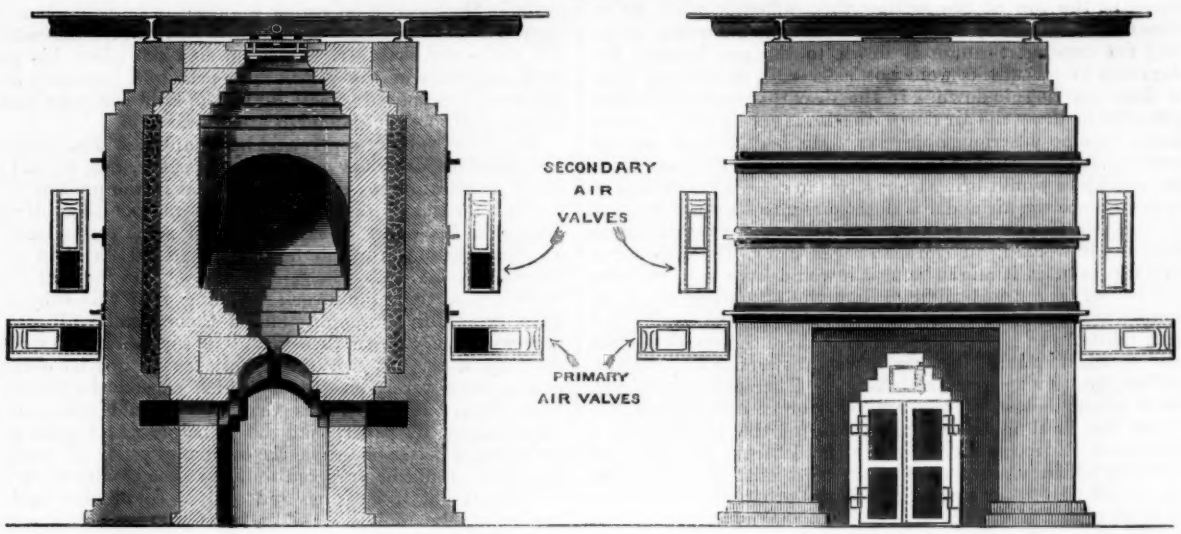


SECTIONS THROUGH REGENERATOR.
(*Enlarged Scale.*)

to admit that there were many practical advantages in the regenerator system, but he should like to have heard more of the economical advantages. It was obvious that the first cost of the setting shown must be greatly in excess of the ordinary setting; but they heard nothing except a passing remark by Dr. Siemens as to the increased production which might be expected. No doubt they could put an extra retort in, but it seemed to him (Mr. Ball) that the first cost of this setting must be very large, and that the economy, as far as fuel was concerned, must vary very greatly in different localities. In his own locality certainly the saving which might result from economy in fuel would be very small indeed compared to the interest on the additional outlay which would be entailed by the erection of such a setting as they saw in the diagrams.

Mr. B. ASKEW (Northwich) wished to know if the two slits at the side of the furnace were the only points where the air was admitted for the combustion of the carbonic oxide. It would seem, he said, that the uniformity of temperature required that there should be a greater number of points for the admission of air, because the points where combustion took place were points of maximum intensity.

GENERATOR OR GAS PRODUCER.—Enlarged Scale.



Section. Elevation.

Mr. Stevenson pointed out on the diagram where the admission of air took place.

Mr. M. S. Greenough (Boston, U.S.A.) said he had not come across the water for the purpose of instructing the British Association of Gas Managers; but at the same time he should not like to remain silent during a discussion in which the advantage of regenerative gas furnaces was questioned. His attention was first called to them three years ago, when he was last over in Europe, and it was Dr. Siemens's furnace in Paris, and the results there obtained, which convinced him of the necessity for other companies doing something of the same sort. A study from the other side of the water of the experiments here had shown him that they must turn to Germany for information on this subject, for there they had worked out the system upon a somewhat more economical plan than they had in Paris. He had just returned from a short tour in Holland, Germany, and France, where he had had the privilege of inspecting these furnaces in several Dutch cities, as well as in Berlin, Dresden, Frankfort, Munich, and other places, so that he thought he was beginning to know something about the various systems. He wished to express most strongly his belief that they would have to come to some system of this kind. One gentleman had just asked for information as to the economy claimed. Now the economy of heating by gas was one point, and the economy of regeneration was another; and a previous speaker was perfectly right in saying it might not pay a company to put in an entirely regenerative system. This would depend on the value of coke in the locality. He might be able to heat his retorts more satisfactorily by a simple furnace, and yet it might not pay him to spend a large sum of money on regeneration. There was no doubt that by a proper system of regeneration, at least 10 per cent. of the weight of fuel could be economized. If the retorts could be heated with an expenditure of 17 to 18 lbs. of coke per 100 lbs. of coal carbonized, by using a gas furnace—and this could be done for 2 lbs. less by efficient regeneration—a very little calculation would show how much coke would be saved in a day, and how much this would be worth. His (Mr. Greenough's) own impression was that where there was a fair price for coke there would be no difficulty in getting back the interest on the capital involved. The point Dr. Siemens put was also a very good one as to the necessity for excavation for a furnace similar to that under discussion, and as to the impossibility of fusing all kinds of coke. Some cokes could be fused, and others, as was the case in Germany, it was impossible to fuse. The same thing was found in America, and this was a matter to be determined by experience, according to the coals of the country. If the coke would fuse and run in a slit furnace, then that was the best one to use; but if not, a hearth, or a grate furnace, must be used. Another point with regard to economy was this: He (Mr. Greenough) did not meet any one in Germany who placed the increased duration of his retorts at less than 15 to 20 per cent. above the time they would last under the ordinary firing and clinkering system. He saw no gentleman who was getting from his retort less than 8500 to 9000 feet of gas per mouthpiece. Now, if 9000 feet could be made instead of 6000, the advantages were perfectly obvious, provided the gas was not spoilt or the retorts subjected to such a heat as to rapidly burn them out, because a much smaller retort-house could be used. His own experience showed him that instead of 7200 feet of gas per mouthpiece in Boston, which they were previously obtaining, they were now, with a system of furnace firing, making from 9500 to 10,000 feet of gas per mouthpiece every 24 hours.

Mr. Alfred Wilson (Middlesbrough), having obtained permission of the President to address the meeting, said he wished to refer to the question of gas regeneration, which was the first point in applying gas to heating retorts. Experience in other branches of manufacturing operations proved that the main advantage arose, not from the use of gas by itself, but from the facilities with which regeneration was coupled with it; it was the regenerative part of the operation which was the most productive of economy, and gaseous fuel was a necessity for regeneration. With respect to the gas generator of which Mr. Stevenson had shown drawings, the question of hot air *versus* cold air, and cold air *versus* air and steam, was one of much interest. Some years ago he (Mr. Wilson) had the opportunity of making prolonged experiments with a gas generator worked by hot air. Most people would admit that that gas generator was most advantageous which gave the greatest facilities of working, and which gasified the greatest weight of fuel, per grate area, in a given time. It would be evident that the use of hot air was desirable if it could be used; but with the ordinary run of English coals it was quite impossible to work a gas generator with hot air, because though the temperature produced was high, it was not sufficiently high to permit the slag to be continuously run out, whilst at the same time it was so high that it did not allow of its being removed in the shape of clinkers. It was just sufficiently high to fuse the ashes and make them stick to the brickwork. It might be tapped out occasionally, but sooner or later the apparatus became blocked. His experience led him to conclude that in hot air generators it was absolutely necessary, when gasifying a large amount of fuel in a given time, to cool the gases rather than make them hotter. In the ordinary generator of Dr. Siemens he believed they gasified coal at the rate of 12 lbs. per square foot of grate area per hour, which was rather a slow speed; but in order to get a larger volume of gas, the apparatus became somewhat cumbrous, whereas if, with cold air under pressure, they attempted to gasify coal at a higher temperature, and if the process were pushed more rapidly, the temperature became so high that it was necessary to use steam to keep it cool. Steam put in at the bottom had two or three useful effects. The first was to keep the bottom cool, and thus to get the clinker; another was that it put the gas under slight pressure; and the third was that while there was no absolute gain with regard to heating power, it tended to produce gas which had less nitrogen in it. After several years of almost constant work, he had made up his mind that in a gas generator worked at high speed, some cooling action at the bottom was absolutely necessary. Referring to the retort setting described in the paper, he thought tiles and bricks would stand perfectly well; but the more important part of the question was this, that the adoption of an underground regenerative plan involved the entire reconstruction of the retort-setting. If the regenerator were

placed at the top of the setting, this difficulty could be to some extent relieved; but in such a case the air would naturally not descend through it down to the gas, because the chimneys in gas-works were not, as a rule, sufficiently high to draw the hot air down. If the draught were sufficiently powerful to draw the air down, the leakages at other points would become a serious objection. He had devised several methods for overcoming these difficulties, and he thought if gas managers would bring themselves to erect a fan or blower so as to place the air under a slight pressure—a small fraction of an inch of water would be sufficient—there would be no difficulty in working an overhead regenerator. The only thing which prevented it might be, that it would have to be built on the top of the retort-setting; but the alteration would be simple, and need not interfere with existing works. He had seen most of the gas-works in Paris, where Siemens's system was at work, and he must say it was answering their expectations, and giving great satisfaction. There the generators were placed below, on the reversing or continuous system. From the level of the charging-floor of the retorts to the bottom of the retort-setting was about 12 feet; but this was a height which was not available in most existing gas-works. He would like to say a word on the gas producer of which he had brought a model, the object of which was to produce the gasification of an increased amount of fuel per square foot of grate area in a given time. He had succeeded in making a good quality of gas at the rate of 30 lbs. of fuel per square foot per hour. The air supplied was introduced at the bottom by ports in the centre of the hearth, and there were no cooling tubes necessary in order to cool the gas. The object of getting an increased output from a comparatively small apparatus had been realized without difficulty. The carbonic acid was about 4 per cent., and he did not think in gasifying fuel at a high rate of speed any apparatus could be worked at a much lower average than this. It was self-contained and exceedingly compact. At the forthcoming meeting of the North British Association of Gas Managers in Glasgow he hoped to have the pleasure of reading a paper in which the application of this gas producer to heating retorts would be fully shown. In conclusion, he said that, when dealing with this subject, it was impossible to omit Dr. Siemens's name. The system of regeneration which he had worked out was of great importance, and any small advances they might make in details were really only links in the long chain of footsteps which bore the stamp of Dr. Siemens's genius.

Mr. J. Chew (Blackpool) said he had no experience whatever in connection with the working of the generative system of heating retorts, and he had no bias except in favour of anything which would be economical in the manufacture of gas. The paper read by Mr. Stevenson was an exceedingly able essay on the chemistry of fuel; but, on the other hand, he did expect, from the two or three years' experience that gentleman had had in the practical use of the regenerator at Peterborough, that he would have favoured them with some absolute facts in connection with the wear and tear and so forth—as to the economical use—of the apparatus. They all recognized that an immense amount of waste heat was spent, going up the chimney, in the ordinary mode of manufacture. When the temperature went down below 1300° or 1400° Fahr. it was of no further use to them; and if there was any advantage in the system devised by Dr. Siemens, it was in economizing waste heat by heating the body of the furnace. On the other hand, gas men, as a rule, required to be convinced that a thing was economical before they spent an enormous amount of capital upon it. This system might have the many advantages stated by Mr. Greenough, but he had seen a great deal of literature on the subject, and, generally speaking, figures as to the actual work had been absent; and it was these figures which they really wanted. On the previous day he went through the Saltley works, where the generator system was in use, and perhaps the gentleman in charge of the works would be able to tell them something about the cost of erection—that was, if they had to alter existing furnaces to the generative principle, what the cost would be, and also something as to the cost of maintenance. This was the kind of information they wanted before they could recommend their Boards of Directors to introduce such a radical change into their works. Most gentlemen knew that some 12 or 14 cwt. of coke was produced from a ton of coal, and probably one-third of it was used for heating the furnaces. The London companies put 32 or 35 per cent. of the fuel carbonized by weight as used for this purpose, and if the regenerator system could reduce the amount by 10 per cent., undoubtedly they would have an increased amount of fuel for sale; but if, on the other hand, the increased amount of fuel was produced by an immensely large expenditure of capital—the interest on which required to be paid—it might happen that "the game" would hardly be "worth the candle." He was sorry that Mr. Stevenson had not given his practical experience of the regenerator principle, especially as he believed he promised something of the kind last year, and as he was still so strong an advocate of it.

Mr. Stevenson, in reply, said he would first deal with the complaint of Mr. Chew and another speaker, that he had not given practical data. The fact was that in the present paper he had intended to deal with the matter theoretically, because in his paper last year, and in some correspondence on the question in which he had taken part, he had given the results of working in various places. He thought it was necessary, as the groundwork for going into this subject, to have the thing thoroughly stated theoretically. It was all very well to cry down theory, and to say facts were wanted. So they were, but working results could not be obtained unless there were some theory which caused the results to take place. His idea was that if he could convince the members, by his paper, that the principle was a right principle, and a better one than the ordinary system of working, then they would be prepared to believe the results when they saw them; but if he came and said he could save half the fuel generally employed, and make the retorts produce twice as much gas as usual, they would be inclined to say, "How is this? We are told simply that if we divide the process of combustion into two stages, after the finality of which we get the same result in heat produced, we can yet obtain all this saving;" and they would say, "We do not believe it." But if they would go into the matter, and see how it was that it was impossible, under the old system, to carry out theory in practical working, whilst on the regenerative system it was not impossible to approach very nearly to theoretical perfection, then the thing became apparent. With regard to the working of the system, Peterborough and Maidstone were the only two places where he had been able to do anything at present with regenerator firing, for he had not succeeded in persuading any of his brother managers to introduce it. At Maidstone they had been working these furnaces throughout the whole of this year, but he was not sure whether Mr. West was present to state the results. They had, however, obtained very satisfactory results there, though he had not visited the works lately. The economy of fuel was such that during a period of half a year some 300 chaldrons more coke were sold than in the previous half year, although 100 tons less coal had been carbonized. At Peterborough they had one furnace working which was constructed as economically as possible with the view of saving the first cost, and he must say he was disappointed with the result, and was fully convinced, after working it for some time, that it was a mistake to try and economize the first cost too much at starting. The depth of fuel was not great enough, and therefore the carbonic acid first produced was not wholly converted into carbonic oxide, and in the gases, as they arrived at the point of secondary ignition, there was a very large proportion of carbonic acid, which maintained the generator in a state of greater heat than it ought to have been. The fact of not having a large open space, but having a small pit made for the men to go into, covered with folding doors, caused very great heat to accumulate in the pit. This furnace was not now working, and he had not as yet made any arrangements for extending or improving the system at Peterborough. The matter involved some personal questions between himself and the Directors of the Company, which he could not go into further; but he could state that the furnaces gave results inferior to those given at Maidstone and in Germany by full-sized furnaces, just in proportion to the imperfect shape and design of the furnace for the purpose for which it was intended, although the results were better than by the ordinary system of working. With regard to the expense of construction, he was prepared to assert that if the regenerative system were universally adopted in any works, the result would eventually be a saving in the capital account. The cost per mouthpiece of one of these settings would, of course, be greater than the cost of an ordinary retort-setting, but he had had a careful estimate of the cost made, and found it came, on the average, to £20 per mouthpiece, with all the fittings connected with the furnace itself, but without the retort-fittings. This included excavation and building a retaining wall in front of the generator, to allow space for moving about and working it. This figure was not excessive, especially considering the fact that one such retort-setting would produce as much gas in a day as two ordinary settings of seven retorts; so that eventually there would be a considerable economy, as the size of the retort-house need only be at the most two-thirds of the size

now required. He calculated the work this setting would do would be to carbonize 15 cwt. of coal per mouthpiece per day, with charges of 2½ cwt. of four hours' duration. The size of the retorts was 16 in. by 22 in., and the production of gas would be 8000 feet per mouthpiece, whereas they now obtained from 5000 to 6000 feet. He did not think that Mr. Peaty's remarks were very happy. He said it was not necessary to produce the gas separately for each retort-setting, nor was it absolutely necessary. Attempts had been made in Germany to work two or more retort-settings with one generator, but the result had always been a loss, through radiation, before the gases arrived at the burners. If the gases were made at a distance, and brought to the retort-settings cold before being used, they would have to be heated again, because unless they were heated up to a considerable temperature they would not ignite when the air supply was introduced. Either the gas must be re-heated, as Dr. Siemens did in his regenerative furnace, or else the air supply must be heated, for if both were cold they would never burn. It must be remembered that they had not to deal with coal to begin with, but with coke; they did not want a generator of an enormous producing capacity, for a moderate-sized one would make all the gas required, nor did they require a strong pressure or draught. They had to deal with gas from coke only, whereas in Dr. Siemens's process the gas was produced from coal or slack, and was carried from the generator by iron tubes along a condenser, by which it became condensed; the tar and heavy hydrocarbons being deposited and left in the condenser, whereas the gas, after being purified, went forward into the furnace. They did not want to cool the gas at all, but to get the gas straight away from the furnace, so as to save loss by radiation. There was considerable loss in a generator built separately from the retort-setting, though if built with duplicate walls, and the inner and outer space filled in with air-tight, non-conducting material, the loss would not be very great. He put it down at 20 per cent., but this was not 20 per cent. of the whole heat produced in the process, but 20 per cent. of the heat produced in the generator, which was about one-third of the total. If the men working in front of the generator felt a great amount of heat coming out of it, this was only part of what was produced in the first combustion, and more than twice as much was produced afterwards in the secondary combustion. Another question was the awkwardness of having so deep an excavation. The depth shown was only 10 feet to the bottom, but he proposed, in designing the setting, to commence building from the bottom; and if a stage house were built, he would simply commence from the coke-floor level, and build the piers straight up instead of building arches, as was usually done in a stage house. The portion not required for the generating flues could afterwards be filled up with concrete, and remain so permanently. Once constructed, the generating flues would last as long as the whole bench. Nothing would require to be touched again except the retorts, and in a few years' time the generator would require re-lining. As to the time the retorts lasted, of course the higher the temperature the sooner they burnt out; but there was a great saving effected from the equable temperature maintained. He found that although the retorts required renewing sooner than when worked at lower heats, the wear and tear, per 1000 feet of gas produced, was not greater. The increased make of gas he referred to last year, and therefore he did not think it necessary to bring it forward again, though it was certainly a very important consideration.

The PRESIDENT said time was going on so fast that he found he should not be able to say what he had intended on this subject; but there were one or two observations made by various speakers to which he must direct attention. The question of comparative economy was one that naturally came to the front, and the first thing to be considered was whether they approved of the increase of heat which these generators would afford. The tendency of working had been gradually to increase the heat of the retorts, and if they endorsed this policy the regenerative principle came in as a most powerful aid. Ordinarily, if they increased the heat of the retorts by hard firing, they lost a large portion of the heat at the outlet; but this the regenerative principle would enable them to return to the furnace, and this, he apprehended, was the chief value of it. Mr. Chew had asked for facts and figures. Figures had frequently been before the Association, but not such figures as commended themselves apparently to the mind of Mr. Chew. He should remind him, however, that it had been frequently stated that by the regenerative system a very much larger make of gas per mouthpiece had been the result. They had been told, over and over again, of what had been done on the Continent; and Mr. Greenough had been able to tell them that wherever he and his friends had been, this system was in use, and that large yields per mouthpiece had been attained—not by enlarging the retort, but with an ordinary-sized retort almost double the yield they in England had been accustomed to had prevailed. He could endorse this statement, having paid a short visit to Germany last year, and seen several of the works to which Mr. Greenough had referred. He had also the privilege of seeing Dr. Schilling, who had studied this subject perhaps with greater care than any one, and had carried out the system to a very high degree of perfection. In his furnace the exit gas would ordinarily have a temperature of 2000° Fahr. If this were the outlet of an ordinary furnace, they could easily imagine what a loss of fuel would result; but by his system of regeneration he was able to bring the air for the secondary combustion into contact with the hot surfaces produced by this 2000°, so that at the outlet his whole gas went away at a temperature of not more than 1000°, the other 1000° being returned to the furnace. The result of this was that although the apparatus was somewhat more expensive to construct, his fuel account was reduced by somewhere about 2 lbs. per 100 lbs. of coal carbonized. The Germans had a different mode of estimating their fuel account to ourselves; they estimated so many pounds of fuel to 100 lbs. of coal carbonized, and Dr. Schilling's fuel account was 15 lbs. to 16 lbs., being a decrease of about 2 lbs. on what was done anywhere else. The question had been asked whether the Birmingham people were in a position to say anything on this subject. He must say he did not think they were in a position yet to say anything very definite. At present they were in the position of scholars, and it did not become scholars to speak very much. They had made several experiments, but they could see very well that this matter was one which required most careful handling, and complete success could only be obtained by a gradual succession of steps. They had arrived at this, however, that there was no doubt they could get any amount of heat for the retorts, but they had not yet attained to an economy of fuel. This, however, was a matter which it was perfectly evident must come. The present result he attributed entirely to the fact that they allowed too much heat to go away at the exit-flues; or, in other words, that they had not yet applied, in a sufficiently perfect manner, the regenerative principle.

[The publication of the remainder of the papers read is deferred to the next number of the JOURNAL.]

MALTA AND MEDITERRANEAN GAS COMPANY, LIMITED.

The Ordinary General Meeting of this Company was held at the London Offices, 60, Gracechurch Street, E.C., on Tuesday, the 21st inst.—Mr. J. B. PADDON in the chair.

The SECRETARY (Mr. F. A. Duffield) read the notice convening the meeting, and the following report of the Directors was presented:—

The Directors beg leave to present to you their report and the audited statement of the Company's accounts for the year ended March 31, 1881.

There has been a considerable decrease in the value of residuals at Malta, but the gross earnings of the Company have not been greatly reduced. A satisfactory improvement in the business of the Sicilian stations has taken place.

During the current year it is intended to make some enlargements and extensions of mains and works, for the purposes of increased business and further economy.

From the profits earned the Directors recommend that, in addition to the first and second preference dividends, a dividend of 3 per cent., free of income-tax, on the ordinary shares be declared, that the sum of £500 should be placed to the reserve fund, and that the balance of £309 12s. 6d. be carried forward to the next account.

One Director, Mr. John Romanes, retires by rotation, and offers himself for re-election. The Auditors, Mr. James le Geyt Daniell and Mr. Alfred Hersee, retire, and offer themselves for re-election.

Profit and Loss Account, for Twelve Months ending March 31, 1881.

Dr.				Cr.			
Coals	£7,235	5	10	Gas	£21,025	8	10
Gas-making (salaries and wages)	2,174	1	2	Coke	2,363	3	4
Charges on street lights	1,187	7	8	Tar	130	10	6
Maintenance	1,271	5	9	Fittings and meters	293	14	5
Purifying materials	71	7	7	Interest and discount	30	5	3
Rents	77	8	2	Transfer fees	7	0	0
General trade charges	723	13	10				
Depreciation of stock	300	0	0				
Bad debts and allowances	276	17	5				
Taxes on meters	122	8	7				
Treasurer's commission at stations and audit fee at Malta	277	9	8				
Inspection of stations	128	13	0				
London expenses	938	11	1				
Law expenses	43	5	8				
Exchange	379	3	9				
Income-tax	45	9	11				
Balance	8,606	13	3				
	£23,859	2	4		£23,859	2	4

The CHAIRMAN, in moving the adoption of the report, stated that on previous similar occasions he had had to refer to the stereotyped character of the accounts, but no such description applied to the history of the Company's affairs for the past year. The chief incidents of the year had been those relating to the contract for the public lighting. The streets of Valletta, Floriana, Vittoriosa, Cospiscua, and Senglea had been lighted by the Company under a contract with the Government for a term of fifteen years. This term would come to an end next May. In November last the Government advertised very extensively for tenders for this lighting. In due course the tender of the Company was sent in, but from that time

up to the present the Directors had not had any formal notification of either its acceptance or rejection. What they did know was that it was the only tender received, and they also knew that some negotiations had been proceeding during this time, and that the Government had resolved upon inviting tenders again. This had only been within the last few days. When the time came they would again send in their tender, and await the result. In the course of the preparation of these tenders it was evident to the Board that it was desirable that one of their body should go to Malta for the purpose of depositing the tender, and initiating negotiations. The member of the Board best fitted for the purpose was Major Suart, who kindly consented to go; and he (the Chairman) was in a position to say that the interests of the Company were very ably and fully represented by this gentleman. Major Suart was detained there a long time, and this time he turned to advantage in making a careful examination of the property, and the mode of keeping the accounts, and he also paid a visit to the Company's Sicilian stations for the same purpose, and returned with a copious roll of notes, which had been found of great value. The charge on the Company had chiefly resulted from the alterations made in bringing the books of their accounts from Malta to the London office, and keeping them there, and the various matters suggested and arising from the examination of the works. These things had brought about changes which had been beneficial, but it was not so much in the present that they would be felt as in the future. He really believed the Company would experience great benefit from the changes now made, and it was their intention to carry them still further with regard to other stations, and to get the business of the Company as much as possible into the London office. The effect of the changes made had been to double the duties of the Directors. For many years these duties were almost judicial, but now they were largely administrative. There was, however, nothing to regret in this. The knowledge of the Directors as to the concern had been considerably extended; and some of the consequent changes appeared in the present accounts. In the profit and loss account, it might be said that all its merits—and there were really some very good points in it—were obscured, almost neutralized, by the decreased value of coke at Malta and Corfu. This was not due to one cause, but to several; and, if taken in comparison with the accounts of last year, it would show that there was a decrease of about 25 per cent. in the total value. He might say that the accounts of last year were exceedingly high, and, looked at by the light of present events, perhaps a little too high. In order to maintain prices last year, a considerable stock was accumulated, and was brought over to the accounts of this year at the average price obtained for it last year, such being the custom; but these prices had not been realized, and this made a loss. Then there had been a slightly smaller yield of coke per ton of coal, and a rather larger fuel account. The two together amounted to about 7 per cent., and they were accounted for by the increased yield of gas per ton of coal. The chief cause of the unfavourable working at Malta was the reduction in the selling price of coke. In the hope of obtaining better prices they had an accumulation of coke, which he thought was larger than they ought to have had, and probably larger than they would ever have again; but finding that the price did not increase, and that there was no prospect of its doing so, the Directors thought it was best not to run the risk of further deterioration, but to realize, and to do this large quantities were sold at a low price. They sold 287 chaldrons more coke last than in the previous year, and received £818 less. The reduction in the selling price amounted to an average of about 4s. 7d. per chaldron. It was not often that so many adverse circumstances came together in one year, and he did not think they ever would again. Going to the first item in the profit and loss account, that of coal, it was slightly higher than in the previous year, and this was chiefly due to a small advance in freights. The next item, gas-making (salaries and wages), was one of the things which showed the advantage of the late examination of the Company's affairs, and the alterations the Board had made. There was a decided economy. The items of charges on street lights and maintenance, if taken together, would be found practically the same as before; and of all the other items he might say that they varied but little, the variation, however, being in the right direction. There was about £480 less expenditure than in the year ending March, 1880. On the other side of the account there was a very small increase in the rental. Coke he had already referred to; tar was a little better; and the profit on fittings and meters chiefly came from the Sicilian stations. The capital raised was practically the same as it was last year—there was a difference of about £30. The debentures were also about £200 less, and the saving in interest was beginning to make itself felt—not largely as yet, but still it was showing some benefit for what had been attempted. With regard to the debentures, there was no disproportion now between the amount raised on debentures and the amount raised as capital; but a number of debentures would be falling due on the 1st of July, and about £1100 would then be cleared off—he would not say permanently cleared off, as it might be to the interest of the Company, if they could renew them on advantageous terms, to do so. As to the items of sundry creditors and reserve fund, if they were compared with those in the preceding balance-sheet they were such as to excuse the Directors if they felt some little pride in them, as they showed undoubtedly an improvement. Since the Shareholders last met there had been an expenditure on capital account of about £520, which had gone in additional mains and lamps. He thought the Directors might say that the whole of this expenditure would be profitable. The other items he thought spoke pretty well for themselves. With regard to the stations at Malta, he was sorry to say that there was a further decrease of rental. Trade was said to be bad there, and the prospects of improvement poor. He mentioned this because if the Company should be called on to make any further expenditure of capital, it would be a matter for the gravest consideration. At Corfu also there was a decrease of rental, but this ought not to be thought too seriously of, as Corfu had been an improving station for some time, and it was considered that the little check there had been in the past year was easily accounted for by the unsettled state of the country, and it was thought would be only of a temporary character. At the Sicilian stations, however, the increase in the rental had been sufficient to make good the deficiency of three large stations, and to show a slight increase upon the whole. The Shareholders might look upon the accounts of these stations being no longer a drag on the Company, but a source of considerable assistance. During the last seven years the rental had increased about 30 per cent. there. In the past year these stations yielded a profit of £1550; and had the whole of the accounts of the other stations been as good as those of the Sicilian stations, the Shareholders would have had a very pleasant state of things before them.

Mr. JOHN ROMANES seconded the motion.

Mr. HARVEY asked in what the reserve fund of £2949 was invested.

Mr. STOKES thought there was very little prospect of any other Company undertaking the new contract referred to, so he considered the Company were pretty safe on this point.

The CHAIRMAN, in reply, stated that the reserve fund was not specially invested. It was used practically as working capital, and he did not know that the Directors could put it to a better use than this. Were they to invest it they would be in this position—that they would be raising capital at 7½ per cent. and investing it at 3, or at most 4 per cent.; and the Company were not rich enough to do this. So long as it kept within its present very moderate proportions, it would, no doubt, be used as working capital. He might say that whatever confidence Mr. Stokes felt respecting the street lighting tender for Malta was fully shared by the Directors.

The report was then put, and unanimously adopted.

On the motion of the CHAIRMAN, seconded by Mr. S. ANDREWS, resolutions were passed declaring dividends of 7 and 7½ per cent. respectively on the first and second preference shares for the year ending March 31 last, deducting payments already made on account. A dividend of 8 per cent. was next declared for the past year on the ordinary shares, on the motion of the CHAIRMAN, seconded by Mr. STOKES.

The retiring Director and Auditors having been re-elected,

Mr. W. T. MORRISON proposed, and Mr. CRAVEN seconded, a resolution voting 100 guineas to Major Suart, in recognition of his services at the Malta and Sicilian stations, and the motion was carried unanimously.

Major SUART, in returning thanks, observed that he went out with some reluctance; and though he could not get any answer from the Government officials, he thought the time had been well spent. It had given one of the Directors some personal knowledge of four of the five of the Company's stations, and he hoped this would eventuate in good.

On the motion of Mr. HARVEY, seconded by Mr. STOKES, a vote of thanks was then passed to the Chairman and Directors.

The CHAIRMAN acknowledged the vote, and in replying to a remark of Mr. Stokes, stated that the Sicilian stations were now in some respects approaching the limit of their capacity, and the third paragraph of the report referred to this. There had been little or no money spent on them for some time; and it was for these stations alone that further capital would be required.

Mr. MORRISON next moved, and Mr. HARVEY seconded, a vote of thanks to the Secretary and the staff.

The CHAIRMAN having briefly supported the motion, it was carried unanimously.

The SECRETARY returned thanks on behalf of his colleagues and himself, and the proceedings terminated.

BRIGHOUSE LOCAL BOARD GAS AND WATER SUPPLY.

At the Meeting of the Brighouse Local Board last Friday,

The CHAIRMAN (Mr. Bottomley) moved—"That a discount of 10 per cent. be allowed off the present price charged for gas (2s. 6d. per 1000 cubic feet), to all consumers who pay their gas accounts on or before the last day of the second month in each quarter; and that such discount commence with the Midsummer quarter's gas accounts, due July 1, 1881." He said he was very glad to find that the profits accruing from the gas-works, after all charges had been met, justified him in asking the Board to reduce in this way the price of gas; and he took this opportunity to say that the results of the manufacture of gas reflected great credit upon the Manager (Mr. James Parkinson), who, he was quite sure, had spared no pains in endeavouring to bring about such a satisfactory state of things. It had been his (the Chairman's) good fortune to be privileged to move that a reduction should be made in the price of gas three years in succession. In 1879 the price was lowered from 3s. 4d. to 2s. 11d. per 1000 feet; again, in 1880, it was reduced from 2s. 11d. to 2s. 6d.; and he had now once more to ask a further reduction. It had always been the custom of the Board to charge both large and small consumers at one uniform rate, and although the principle of discount was to be introduced, the price would continue uniform. The arrears, bad debts, and loss of interest to the Board had been very considerable; in fact, the Auditor had drawn attention to the great amount of arrears, and the principle of discount was introduced with a view of offering an inducement to punctual payment of gas accounts. He was glad to say that the arrears were £900 less last year than they were the previous one. His resolution would mean that all who paid their gas accounts within two months of their being due would have their gas at the rate of 2s. 3d. instead of 2s. 6d. per 1000 feet.

Mr. R. SUGDEN asked if the large consumers were not paying more than their fair share, judging by the profits made.

The CHAIRMAN pointed out what he had stated before, that the custom had always been to charge one uniform rate. If any gentleman wished to alter the system, it would be open to him to propose a resolution to this effect. He was wishful, however, that the people living in cottage property should have a chance of keeping their houses bright and clean.

Mr. KERSHAW thought that large consumers took the gas solely for their own benefit. He endorsed what the Chairman had said with respect to the excellent management which had produced such satisfactory results in the gas department. The Chairman had not stated, however, what the amount of profit was.

The CHAIRMAN said that the reduction in the price of gas was equal to the profit made.

The resolution was then seconded by Mr. ORMEROD, and carried.

The CHAIRMAN also moved the following resolution:—"That the price of water supplied for trade purposes be reduced to all consumers within the district of the Local Board, from 1s. to 10d. per 1000 gallons, and to all consumers outside the district, receiving a supply from the Board for trade purposes, from 1s. 6d. to 1s. 3d. per 1000 gallons; that such reductions commence and take effect on and after the 1st day of April; and that all hydrants be free." This motion was seconded by Mr. KERSHAW, and, after some conversation, was carried unanimously.

CHELSEA WATER-WORKS COMPANY.

The Half-Yearly General Meeting of this Company was held at the Office, Commercial Road, Pimlico, on the 23rd inst.—JOHN DEEDES, Esq., the Governor, in the chair.

The SECRETARY (Mr. Albert Gill) having read the notice convening the meeting, and the minutes of the last half-yearly meeting, the following report for the six months to March and the accounts were presented:—

The revenue for the half year, exclusive of interest on moneys invested and deposited, amounted to £50,647 2s. 9d., showing, as compared with the revenue of the corresponding period of last year, an increase of £1092 4s. 10d.

The charges for maintenance and management were £17,156 4s. 1d., and show, as compared with the charges for the same period of last year, an increase of £718 2s. 11d. The account is charged with unusually heavy expenses incident to the severe frost which set in in January last. The disturbance of roadways for the extension of wood paving continues to swell the working expenses. That work has been completed in many parts of the Company's district, but some further expenditure of the same kind may be looked for in other parts, where the authorities have signified their intention to use wood as the covering for some of the principal thoroughfares.

In accordance with the report presented to the Proprietors in December last, the law costs incurred in opposing the Lower Thames Valley main sewerage scheme, and the costs of the proceedings in the matter of the proposed Purchase Bill of last session, amounting together to £1704 13s. 9d., have been provided for out of the contingency fund. The same account has also been charged with the sum of £241 16s., paid as compensations for damages incident to the bursting (in October last) of a 24-inch main at Walham Green.

The expenditure on capital account during the half year amounted to £867 7s. 3d. The outlay is again chiefly due to the extension of mains in the suburban portions of the district in the direction of Fulham. During the half year 92 houses have been pulled down and 302 new houses laid on. From this source, and the steady increase in the quantity of water supplied by meter, considerable additional revenue is anticipated,

though its development is, for the present, retarded to some extent by the unusual number of houses returned as empty.

The quantity of water pumped from Surbiton to the covered service reservoirs on Putney Heath during the half year amounted to 1515 million gallons, being about 36 millions in excess of the quantity pumped in the corresponding period of last year, though the cost of coal was rather less. The inspection of water fittings is still in active operation.

The Engineers report that the whole of the Company's works and property are in excellent order, that the intake at Molesey continues to act satisfactorily, that the flow of water to the screen tanks was in no way checked by the severe frosts of the past winter, and that little inconvenience was caused by the floods, the store in the reservoirs having been replenished at every opportunity, and the water maintained in good condition.

No reliable information has reached the Directors as to whether or not the Government have still the intention of introducing a Bill with reference to the several London Water Companies; but should any action be taken, it will engage the most careful consideration of the Directors.

A Bill has been introduced into Parliament authorizing the Metropolitan Board of Works to construct a new bridge to replace the present wooden bridge across the Thames at Putney, and involving the removal of the Company's aqueduct. Clauses have been inserted in the Bill for the protection of the Company's rights and interests and the continuance of their water supply across the river by means of a temporary iron structure to be erected and maintained by the Metropolitan Board during the progress of their works. The Bill further provides that on completion of the new bridge the Metropolitan Board are to lay down (under the footways of their new bridge) mains of the same number and diameter as are now carried by the aqueduct bridge, and to provide and leave under the footways space sufficient for the admission of two additional 24-inch mains.

Another Bill, entitled the Kingston and London Railway Bill, authorizes the construction of a line from the railway station at Fulham Bridge through Putney and underneath Wimbledon Common. The line will pass by tunnel near to the Company's service reservoirs on Putney Heath, and clauses have been inserted in the Bill, by arrangement, for the protection of the Company's interests.

The Directors feel that they may congratulate the Proprietors on the soundness of the Company's financial position, on the thorough efficiency of their works, and on the excellent quality and abundant quantity of the water supplied to the district. They recommend that a dividend on the ordinary stock at the rate of 6¼ per cent. per annum be declared and paid as usual on the 5th of July prox.

Three Directors—Sir William Henry Wyatt (Deputy-Governor), Mr. Francis Stephen Clayton, Col. Sir Wilford Brett—go out of office this year by rotation, but offer themselves for re-election. Mr. James Alfred Hallett, one of the Auditors, also goes out of office by rotation, and offers himself for re-election.

Dr.—REVENUE ACCOUNT, FOR THE HALF YEAR ENDED MARCH 31, 1881.

Maintenance.			
Maintenance and repair of impounding and service reservoirs, &c., including materials and labour		£716 18 0	
Maintenance and repair of mains, pipes, &c., including materials, labour, &c.	£2564 2 2		
Do., withdrawn from contingency fund	241 16 0		
		2,805 18 2	
Pumping and engine charges, including cost of coals, wages, &c.		3,675 11 5	
Filtration, including the cost of materials and labour		434 15 2	
Salaries of Engineer, Inspector, Superintendent, and Clerks, and wages of Turncocks		2,106 10 0	
Thames Conservancy		1,000 0 0	
Rates and taxes, exclusive of income-tax		2,438 16 1	
			£13,178 8 10
Management.			
Allowance to Directors		£630 0 0	
Allowance to Company's Auditors		41 7 0	
Salaries of Secretary, Accountant, and Office Clerks		1,137 17 0	
Superannuation of servants of the Company		367 11 0	
Commission to Collectors		1,301 12 2	
Stationery, printing, and general establishment charges		355 0 3	
Law and parliamentary expenses		328 6 10	
Do., withdrawn from contingency fund		1704 13 9	
Official Auditor and Water Examiner		57 17 0	
			5,924 5 0
Dividend and interest account for transfer of profits			30,490 18 8
Balance carried to next account			3,000 0 0
			£52,593 12 6

Cr.—REVENUE ACCOUNT.

Balance brought from former account		£3000 0 0	
Sums written off as losses, viz.:—			
Empty houses	£2832 9 3		
Bad debts	171 2 0		
	3003 11 3		
	£3 11 3*		
Water-rates accrued to date of this account		£50,388 5 6	
Less, as above*		£3 11 3	
			£50,384 14 3
Rents of houses and lands accrued to date, and owing to the Company			245 16 0
Fees received for registration of stock, transfers, &c.			16 12 6
Contingency fund			1,946 9 9
			£52,593 12 6

The GOVERNOR, in moving the adoption of the report, said he thought the Directors might congratulate the Proprietors upon its being satisfactory in all respects. It showed an increase of revenue in the half year up to March 31 last of £1092, but on the other side there was an increase in the charges for maintenance and management of £718. This increase was principally accounted for by two circumstances—the unusually severe frost which lasted so long, and the expenses to which the Company were put by the laying of wood paving; the pipes being examined when the wood paving was laid down. There was likely to be a further increase on this head, from the paving of Whitehall, Victoria Street, and the Broad Sanctuary, with wood. The report referred to the expense incurred in opposing the Lower Thames Valley Main Sewerage Bill, and also the costs of the proceedings in respect to the Metropolis Water Supply Bill of last year, which amounted together to £1704, and the burst of the main at Walham Green, which further increased the amount to £1945. This sum had been charged against the contingency fund. Fortunately, there was a good contingency fund, which, under the Company's Act of Parliament, was made available to meet contingencies—a very wide expression—or for enlarging, repairing, and improving the works. The report further stated that "during the half year 92 houses have been pulled down and 302 new houses laid on. From this source, and the steady increase in the quantity of water supplied by meter, considerable additional revenue is anticipated, though its development is, for the present, retarded to some extent by the unusual number of houses returned as empty." The increase in the quantity of water supplied by meter was for trade purposes, and as regarded the "empties," the state of the case seemed to be this: They were mostly in respect of new houses. At Michaelmas, 1879, the total supplies in the whole district amounted to 29,945, and the empties at the time were 1616. At Michaelmas, 1880, the supplies were 30,375, being an increase of 430, and the empties were 2226, an increase of 616. He had very little doubt that in course of time these new houses would become occupied, and money would then be received from them. Another paragraph referred to the action of Parliament with respect to the Companies, and he had nothing to say on this head. Rumours were afloat from time to time, but there was nothing to put one's finger upon to show any certainty of action this session on the part of the Government, and he presumed that none would take place. With reference to the new bridge across the Thames, the Directors did not expect any litigation in regard to the matter. Clauses had been agreed upon which would obviate this, and the whole thing seemed to have gone on agreeably to all parties. The report mentioned another Bill—the Kingston and London Railway Bill—and there again everything had gone on smoothly. With respect to the quality of the water, he would read some short extracts from the reports of three gentlemen of distinction and eminence—Mr. Crookes, Dr. William Odling, and Dr. Meymott Tidy. The reports of these gentlemen were sent to the President of the Local Government Board, and their observations were made daily, though the reports were made monthly. In their report for the month ended April 20 they said: "Of the 23 samples from the mains of the Chelsea Water Company, the whole were bright, clear, and well filtered." Further on in the same report they said: "The improvement we had occasion to mention as having taken place in the appearance of the metropolitan waters in our last report has been still further noticeable during the past month, and, taken as a whole, they leave nothing to be desired in respect of colour, wholesomeness, complete aëration, or absence of suspended matter." Again, in their report for the month ended May 19, they said: "Of the 26 samples from the mains of the Chelsea Water Company, the whole were bright, clear, and well filtered;" and this report they closed by saying, referring to the waters supplied by the Companies generally, "Examined chemically, they have shown excellent aëration and great freedom from organic matter. They leave nothing to be desired for dietetic purposes." He thought those reports must be regarded as satisfactory.

Mr. G. F. ASTON seconded the motion, which was carried unanimously.

On the motion of the GOVERNOR, seconded by the DEPUTY-GOVERNOR (Sir William Henry Wyatt) the following resolution was passed:—"That the accounts as laid before the meeting be received and entered on the books;" and further resolutions were afterwards passed authorizing the Directors "to set apart out of the profits of the Company so much money as will be sufficient to pay the dividends which will become due on the 5th day of July next on the several preference stocks issued by this Company," and declaring a dividend for the past half year at the rate of £6 10s. per cent. per annum on the ordinary capital stock of the Company.

The GOVERNOR next moved the re-election of the retiring Directors, and the motion having been seconded it was carried unanimously; as was a further resolution re-electing the retiring Auditor.

Mr. CHESSHIRE, F.R.S. (Birmingham), urged the Directors to direct their attention to giving a constant supply. Cisterns were, he said, very much neglected, and the consequence was that the Companies were frequently blamed as to the badness of the quality of the water supplied, when in reality the blame was due to the neglect of the consumer to keep his cistern properly cleansed.

The GOVERNOR, in reply, said he was happy to inform the Shareholders that the Company certainly did not receive complaints. He might state that the question of the constant supply was invariably prominently before the Board. Wherever it could possibly be applied, especially in new houses, it was put on.

The DEPUTY-GOVERNOR thought it right to mention that it would not make the least difference as to the cisterns if the constant supply were general, for cisterns must be used. No water company in London could answer that there would not be a momentary suspense from some accident or some cause or other, and if the cisterns were abolished people would, in such event, be without a supply of water.

Mr. CHESSHIRE said he believed that at Birmingham the constant supply had been used without any cisterns whatever, excepting the cisterns at the closets; and he did not see why, if the pressure was sufficiently kept up, they should not have the constant supply without any cisterns, except those at the closets.

The DEPUTY-GOVERNOR: I should not advise it.

A vote of thanks was then passed to the Governor and Directors for their care and attention to the affairs of the Company in the past half year, and the proceedings closed.

NOTES FROM SCOTLAND.

(FROM OUR EDINBURGH CORRESPONDENT.)

EDINBURGH, *Saturday.*

If Dean of Guild Scott, of Montrose, is desirous to earn a reputation for consistency, the sooner he reconsiders his recent utterances the better. Nine months have come and gone since the electors of Montrose were called upon to select and elect municipal dignitaries, and although many events of national and local importance have occurred in the interim, the passionate and eloquent appeals of Dean of Guild Scott, on the gas question, have not been forgotten. Just nine months ago the Dean, in his zeal for the welfare of the town, the management of the affairs of which is partly entrusted to him, wanted to make a raid on the Gas Company, to acquire from them the property they possessed, and in this way give to the community cheaper gas than they were at the time getting. Winding up a somewhat pithy address to the electors with "go in for the gas," one would naturally expect to find him, during these nine months, working hard to achieve for his constituents the very thing that he so warmly urged them to acquire; but somehow or other this is not the case. Not only is he not rendering assistance to attain this object, but he is throwing the weight of his influence, such as it is, into the scale against the acquisition of the gas-works, and one could imagine that if only Dean of Guild Scott could see the Gas Company compelled "to kick the beam," he would, in the exuberance of his joy, don the national garb, and physically gyrate as much as he has already done mentally. It will be gathered that Dean of Guild Scott, who nine months ago advised the community "to go in for the gas," is prepared to go in for something else; but it would not be in the least degree startling if, before the November elections come round again, he should be found seriously considering the position. Meanwhile he says it is truly refreshing to see the Council, with scarcely an exception, following his lead in this matter. Do not let it be supposed that when Dean of Guild Scott uses these words he means his nine months' old lead; he speaks of the electric light, the dazzling rays of which seem to have penetrated even into Montrose, and he appears determined to do all he can to compel the burgh to spend funds which he and his brother councillors are pledged to conserve. It is unfortunate when the Dean is in this frame of mind, and when he has those in the Council prepared to follow his lead, that the Gas Company should not have met the representatives of the town, when they were talking over the purchase of the works a short time ago, in a more frank and considerate spirit. As the Provost sarcastically told the Council on Tuesday night, the Committee appointed to confer with the Gas Company's Directors had received every kindness from these gentlemen, who sought to withhold nothing but information. It is said that the Directors declined to lay their balance-sheets before the Committee, or give any statistics to show whether the consumption of gas was increasing or decreasing in the town. All they would admit was that the dividend of £3 per share had been fairly earned, and that the utmost farthing had been divided. From what transpired at the conference, the Provost said he believed the Company would sell the gas-works for something like £95,000, which the Provost thought would only be a fair price. If I am not mistaken, the value of the works which was brought out by professional gentlemen in November last was something between £17,000 and £18,000. Some of the

members of Council who entered that body pledged to acquire the gas-works think they have, in the electric light, a sufficient ground for violating their pledges, and I understand that the result of the meeting of the Town Council is that, on account of the progress of the electric light and the difficulty of obtaining information from the Gas Directors, no further steps are to be taken in the meantime with a view to negotiate the transfer. Suppose, when gas was first introduced, the candle makers had met and passed a resolution that, owing to the progress which gas-light was making, they should cease their manufacturing operations, what would have been the verdict by all men of sound common sense at the present day? Much in the same way, it may safely enough be predicted, the generation which succeeds the one now in possession of the boards will look back and wonder that their predecessors had such a miserable opinion of the valuable lighting and heating agent which the application of science had placed within easy grasp.

I mentioned last week that the Edinburgh Town Council had resolved to spend £400 in experimenting with the electric light in the city, and that the Brush system had been recommended for adoption. It is said the North British Railway Company have also made arrangements to have the Waverley Station lighted by electricity during the progress of these experiments. I have frequently heard certain rumours that in these experiments there is an under-current of motives, which, if true, are the reverse of creditable. Any one acting for the supposed good of the community should be, like Cæsar's wife, "above suspicion," and if at all interested—pecuniarily, of course—in the advancement of any particular system of electric lighting, that one should shun taking part in any contemplated arrangement. In saying this much, I do not for a single moment attribute unworthy motives; but when parties have an interest in the system which they are recommending to their fellow-townsmen, they cannot be too careful in the part they act.

The Committee who have to do with the exhibition of gas apparatus in Aberdeen met on the forenoon of Saturday last, and made final arrangements for advertising the exhibition, and for communicating with the various firms likely to contribute apparatus. The exhibition will be opened in Marischal College on the 20th of September, and will remain open for a fortnight.

In the month of November last the Commissioners of Alva adopted the Burghs Gas Supply (Scotland) Act, 1876, and thereafter entered into negotiations with the Gas Company for the acquisition of their works. The Commissioners in due course made an offer of £7800 for the works, this offer being based on a valuation by Mr. Clinkshill, of Glasgow. The Company wanted £8500, but, after consideration, they, at a meeting held on Monday evening, agreed to accept the offer of the Corporation.

The annual meeting of the Dunfermline Gaslight Company was held on Wednesday, and the minutes of former meetings having been read by Mr. Mackenzie, the report of the Directors, showing highly satisfactory results on the year's working, was submitted to the meeting and approved of. A dividend of 8 per cent. was declared. Messrs. G. Wilson, J. Drummond, and J. Sampson were elected Directors in room of Messrs. D. Russell, R. M. Wilson, and Henry Reid.

The people of Forfar are now looking forward to the speedy introduction of their new water supply. The main-pipe has been filled for twelve months, and not a single leak has occurred for half this period. The house connections are to be proceeded with immediately, but it has been found necessary, owing to the great pressure of the water, to increase the weight of the lead service-pipes.

For a considerable time past complaints have been made in various districts in Aberdeen as to scarcity of water, and at last the City Surveyor, Mr. Boulton, C.E., was called upon to report on the matter. If there is not abundance of water at the reservoirs, there is at least sufficient for all purposes in Aberdeen, and the cause of the complaint, therefore, is not on this score, but rather that the main-pipes have not sufficient diameter to pass the requisite quantity. Mr. Boulton has drawn up a comprehensive scheme for improving the mains and services, the carrying into effect of which is estimated to cost from £8000 to £9000. At the reservoir the outflow bye-pass and inflow-pipes, 27 inches diameter, are, in Mr. Boulton's opinion, all too small, and he proposes to substitute pipes of 36 inches diameter. If these operations are sanctioned by the Council—at present they are under consideration—the water will require to be shut off from the town for ten or twelve hours.

Several years ago the town of Dunfermline resolved upon introducing an extensive water scheme, and for this purpose they obtained powers to borrow £70,000. A supply of water was obtained from Glensherup, and it was understood to be both plentiful and pure. At a meeting of the Council last week, however, a question was put to the Master of Works, whether all the water coming into the town was being filtered. It was explained that the water coming in by Milesmurk and Townhill could not be filtered. The gentleman who put the question then produced from his pocket a bottle containing "a horsey eel, black in colour, about 18 inches long, and about the thickness of a stocking wire," which he had found in the water coming to his house. The Provost explained that it was believed these creatures came from Craigluscar, where the water was comparatively stagnant, and part of which came through the unfiltered pipe at Milesmurk. Such an explanation is pleasant for those who get their domestic supply from this source, but there is a certain amount of consolation in the fact that the whole of the town will soon be supplied with water from Glensherup.

(FROM OUR GLASGOW CORRESPONDENT.)

GLASGOW, *Saturday*.

A reduction of 5d. per 1000 cubic feet has been made in the price of their gas by the Grangemouth Gas Company, the charge to the consumer now being fixed at 4s. 1d. per 1000 feet. For 27-candle gas in a little provincial town, this is certainly not a high price; but it should be noted in passing that there is a meter-rent of 2s. 6d. per annum.

The Bo'ness Gas Company have resumed operations for giving a larger supply of gas to the consumers. The old 4-inch pipes have been lifted throughout a large portion of the town, and replaced by 9-inch mains, and thus it is confidently anticipated that there will be a decided improvement as regards the quantity of gas available for consumers. This matter being now attended to, a hope is expressed that the quality and price of the gas will next occupy the attention of the Gas Company. I may mention that the price at present is 5s. per 1000 feet for 27-candle gas, with a meter-rent of 2s. per annum.

The annual meeting of the Gourock Gas Company, Limited, was held last Wednesday—Mr. J. Paton presiding. The balance-sheet was submitted and approved of, and a dividend at the rate of 7½ per cent. per annum was declared. In the course of his remarks, the Chairman congratulated the Shareholders on the improvements which had been effected at the gas-works in the course of the past year, and he considered that since those improvements had been completed the works would compare favourably with those of any town of the same size in the United Kingdom. Mr. W. Turner, Mr. J. Simpson, and Mr. W. Lang were elected Directors for the current year, in room of those retiring.

On Tuesday evening the annual general meeting of the Catrine Gaslight Company was held, at which there was a large attendance of Shareholders. From the report which was submitted by the Treasurer (Mr. A. Cowan), it was shown that the financial condition of the Company was not satisfactory, although the works and plant were in first-rate order. The report was adopted, and a dividend of 2½ per cent. declared. It is said that the dividend has not been so low since the formation of the Company. The price of the gas is 6s. 8d. per 1000 cubic feet. It may be mentioned that Catrine is an important seat of the cotton manufacture in Ayrshire.

A very different state of affairs was shown at the annual general meeting of the Auchinleck Gas Company, which was held on Friday, the 17th inst. From the report, which was submitted by the Secretary on behalf of the Directors, it appeared that the Company were in a more flourishing state than had been known for several years. It was unanimously agreed, on the recommendation of the Directors, to declare a dividend of 5 per cent.

The annual meeting of the Muirkirk Gaslight Company was held last Monday—Mr. Charles Howatson, of Glenbuck, in the chair. The usual dividend of 10 per cent. was declared, and the price of gas was continued at 5s. per 1000 cubic feet, which was regarded as moderate, considering the great length of pipeage for the small consumption. But it ought likewise to be mentioned that the Muirkirk Gaslight Company have a large deposit of excellent cannel coal at their very door.

I incidentally referred in last week's "Notes" to the annual report of the Hawick Gaslight Company, and now proceed to notice it more in detail. It embraces the 50th annual balance-sheet and statement of affairs of the Company. After dealing with the movement for removing the entire works to a new and more eligible site, as was agreed upon by a special meeting of the Shareholders last December, it states what the intentions of the Directors are as to the execution of the wishes of the Shareholders as expressed at the meeting. As mentioned last week, the past year's increase in the consumption of gas was upwards of 4 million cubic feet, and for every ton of coal delivered at the works 9200 feet of gas were sold. The percentage of loss by condensation and leakage was sensibly reduced during the year, notwithstanding the fact that the streets were more than ordinarily disturbed, owing to the laying of sewage connections and the new water-supply pipes. During the year ending the 1st of February last the sum of £4712 was received for gas supplied, and the profits earned during the year are set down at £1073—a result which speaks very favourably for the entire management of the Company's business. A year ago the price of gas was reduced from 3s. 9d. to 3s. 6½d. per 1000 feet, and still the guaranteed dividend of 10 per cent. has been earned, besides carrying forward a balance of £148. The sum of £100 13s. 6½d. was paid as discount during the year to large consumers, as against £70 10s. 2d. in the preceding year. This fact shows that the staple trade of the town has been in a more flourishing condition during the past than during the preceding year.

Glasgow Corporation 9 per cent. Gas Annuities were firm yesterday at £227, and buyers were willing to purchase at that rate, but sellers held out for £230.

The new water-works for the parish of Blantyre (in the middle ward of Lanarkshire), which have been in course of construction since last September, and are now approaching completion, were lately inspected by Mr. A. G. Murray, C.E., Edinburgh, as Commissioner for the Board of Supervision. This inspection was rendered necessary by the application of the Local Authority for the recommendation of the Board to a loan of £10,000 from the Public Works Loan Commissioners, to defray the cost of the works. The Board have now recommended the loan, and state that they are satisfied as to the nature of the works executed and to be executed, and the mode of execution; and having regard to the durability of the works and the amount of rates charged and proposed to be charged upon the district, they are of opinion that the loan may be safely spread over a period of 50 years. The result of the Board's recommendation is that the Local Authority will be able to obtain a loan, repayable in 30 years at 3¾ per cent., in 40 years at 4 per cent., or in 50 years at 4¼ per cent.

On the 11th of June the supply of water in the various reservoirs belonging to the Greenock Water Commissioners amounted to 423,428,428 cubic feet, being equal to a supply for all purposes for 121 days, as against a supply for 101 days at the same time last year.

Messrs. Leslie, Engineers, Edinburgh, have devised a water supply scheme for the town of Lockerbie, which is estimated to cost £3360.

It is probable that arrangements will be made by the Irvine Water Commissioners to supply Nobel's Explosives Company with water at the rate of 4½d. per 1000 gallons, on condition that the quantity taken is at least 5 million gallons per annum.

The water supply is assuming a serious aspect at Wishaw, owing to the limited amount contained in the reservoirs and being yielded by the springs and streams.

A very large amount of business has been done this week in the Glasgow pig iron market, and prices yesterday afternoon were—sellers, 47s. 7d. cash and 47s. 9d. one month, buyers offering 1d. per ton less.

Little or no change for the better can be reported in regard to the Scotch coal trade. Many of the gas companies and corporations have now completed their gas coal contracts for the ensuing year, but the Glasgow Gas Committee are still in the market for about 200,000 tons.

BURNLEY CORPORATION GAS AND WATER SUPPLY.—The Borough Auditor of Burnley (Mr. G. Gill) has issued his annual report on the finances of the Corporation for the past year, in which it is stated that, in the gas-works department, the net profit, after appropriating £2500 as reserve fund, amounts to £2371 2s. 7d. The capital account showed that £8756 was expended on works in connection with the gas undertaking, and £6072 on the water-works. The total storeage capacity of the three reservoirs is 172 million gallons, and there are now 12,780 water consumers, as compared with 4510 in 1855. The gasholder capacity is given as 786,000 cubic feet, but it is stated that when the additional gasholder now being erected is finished the storeage will be increased to 2 million cubic feet.

TICEHURST GAS COMPANY.—The annual general meeting of this Company took place last Saturday week—Mr. E. Currie in the chair. The report which was presented stated that owing in part to the reduction, two years since, in the price of gas to 5s. 10d. per 1000 cubic feet, the consumption had rapidly increased, showing for the past year a total of 2,506,300 cubic feet, realizing the sum of £731 0s. 1d., while the amount received for coke, tar, &c., reached the sum of £159 3s. This was effected with a carbonization of 312 tons of coal, showing that 8033 cubic feet of gas had been sold per ton of coal carbonized. The result proved that the coal was of good quality, that the mains and services were in a sound condition, and that industry and good management pervaded the works and business of the Company. The report having been adopted, a dividend of 5 per cent. was unanimously agreed to, and it was resolved to further reduce the price of gas to 5s. 5d. per 1000 cubic feet for the ensuing year.

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